OCTOBER, 1938

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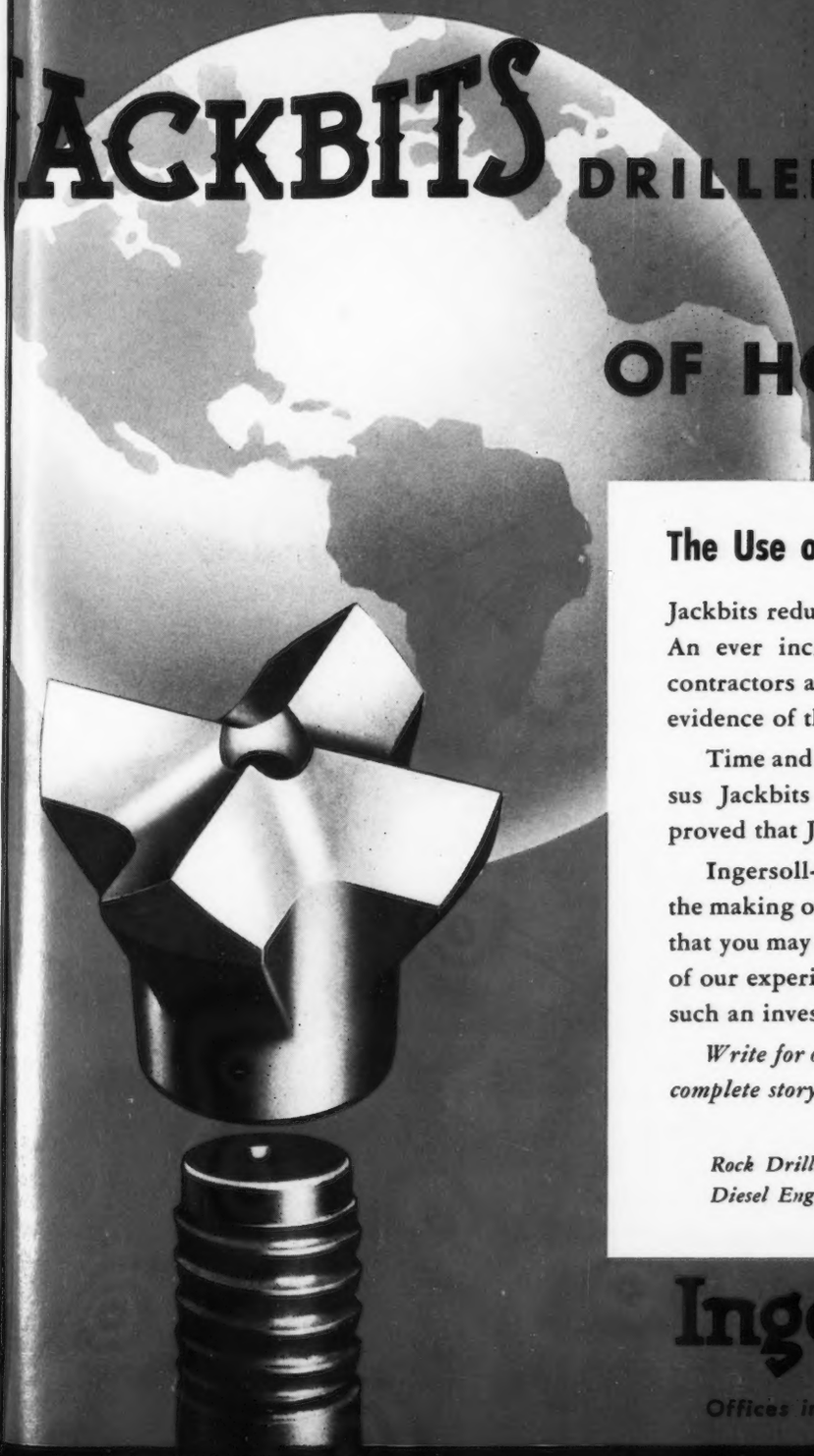

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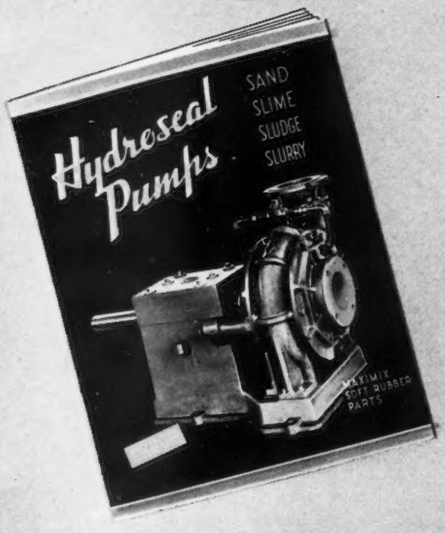

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OCTOBER 1938

On Defining "Sink-and-Float"

CURRENT INTEREST in the ore beneficiation processes that are referred to, more or less loosely, now as "sink-and-float," now as "heavy-medium" separation, and still again as "apparent density" and "differential density" processes, depending on the medium and equipment used as well as on the fancy of the experimenter and operator, warrant the direction of some effort toward defining the various terms. In fact, the current interest is current confusion, in many lay minds at least. Of all these terms, "sink-and-float" is at once the oldest and unquestionably the broadest, inasmuch as in all such processes two products are obtained, one that sinks and one that floats, and usually a third that remains in teeter. The other terms have their special applications.

Perhaps the best way of attacking this problem of nomenclature at the outset is to give the opinions of some experimenters. One researcher applies "sink-and-float" to the separation of two classes of particles by a medium having a density intermediate to those of the particles, irrespective of whether the medium is a heavy liquid chemical, a solution of a heavy salt, or a suspension of fine material. All processes where rising currents or other mechanical means are used to aid the separation he considers forms of gravity concentration, regardless of the medium. The term "apparent density" he has employed as a measure of the separating power of a medium when mechanical means, such as rising currents, are used, and is equivalent to the density required for static "sink-and-float" separation. "Heavy-liquid separation," he suggests, might be confined to separation by fluid chemicals and solutions, and the term "heavy-fluid separation" might include suspensions.

On the other hand, a second researcher regards the term "sink-and-float" as applicable to any process using a heavy suspension, with or without the aid of a rising current, and adds that in all "sink-and-float" work there is a certain amount of hindered settling that helps control the separation.

Opinions of readers will be welcome. Free discussion will doubtless clarify and eventually simplify the terminology of a process on which a great deal of experimentation is under way, and about which we should speak with precision if confusion is to be avoided.

Power for Metals

FOR SEVERAL YEARS past a study of the future power requirements for electrometallurgical and related industries has been under way by the Federal Power Commission. In mid-September the resulting report was issued. In it appears the inevitable conclusion that among the major requirements in America for electrical energy in industry are those for the production and processing of metals and other mineral products. In 1936, the last year for which data are available, consumption of electrical energy for the industries under investigation was approximately 13,300 million kilowatt-hours. Of this total the metal and mineral industries required about three-fourths.

Estimates of future requirements for power, probable within five years, emphasize the fact

that some of the major increases in demand will be found in the same metal businesses as are now most prominent. The report estimates a total energy demand per year, within the period named, of about 17,800 million kilowatt-hours—an increase of 30 to 40 per cent. The accompanying tabulation shows the major items of interest to the metal and mineral industries, as well as a few important electrochemical figures for comparison.

Consumption of Electrical Energy

Kw.-Hr. per Year

Product	Past Requirements	Probable Requirements Within Five Years
Aluminum	2,597	3,600
Copper	2,600	2,500
Zinc (electrolytic)	515	850
Magnesium	39	100
Chlorine and caustic soda (electrolytic)	1,568	1,900
Electric-furnace iron	105	200
Electric-furnace steel	743	1,100
Electric-furnace ferro-alloys	1,752	2,500
Heat-treating	2,200	3,000
Artificial abrasives	87	116
Calcium carbide	550	1,100
Carbon and graphitized products	196	300
Nitrogen	288	375
Potash	84	140
Totals	13,324	17,781

With the exception of copper, all of the products show a substantial increase in probable demand for electrical energy five years hence. A reduction of about four per cent for copper might suggest better technical efficiency in electrolytic refining, but more correctly reflects the declining ratio of domestic to world production of the red metal. On the other hand, substantial increases are shown for aluminum and electrolytic zinc, the former continuing to make competitive headway with other metals, and the latter encroaching gradually on the less refined product of the retort process.

The President has used this matter of the importance of electric power in industry as an excuse for naming a new committee to study war-time power needs. All of which has given utility managers fresh cause for concern. Despite the obvious importance of power in national preparedness, the utilities feel that the new study is intended only to furnish another basis for utility control and the establishment of more regional power projects of the T.V.A. type. They are probably right that this is a part of the purpose of the new committee, but it has in reality, as well as nominally, a big preparedness job to do.

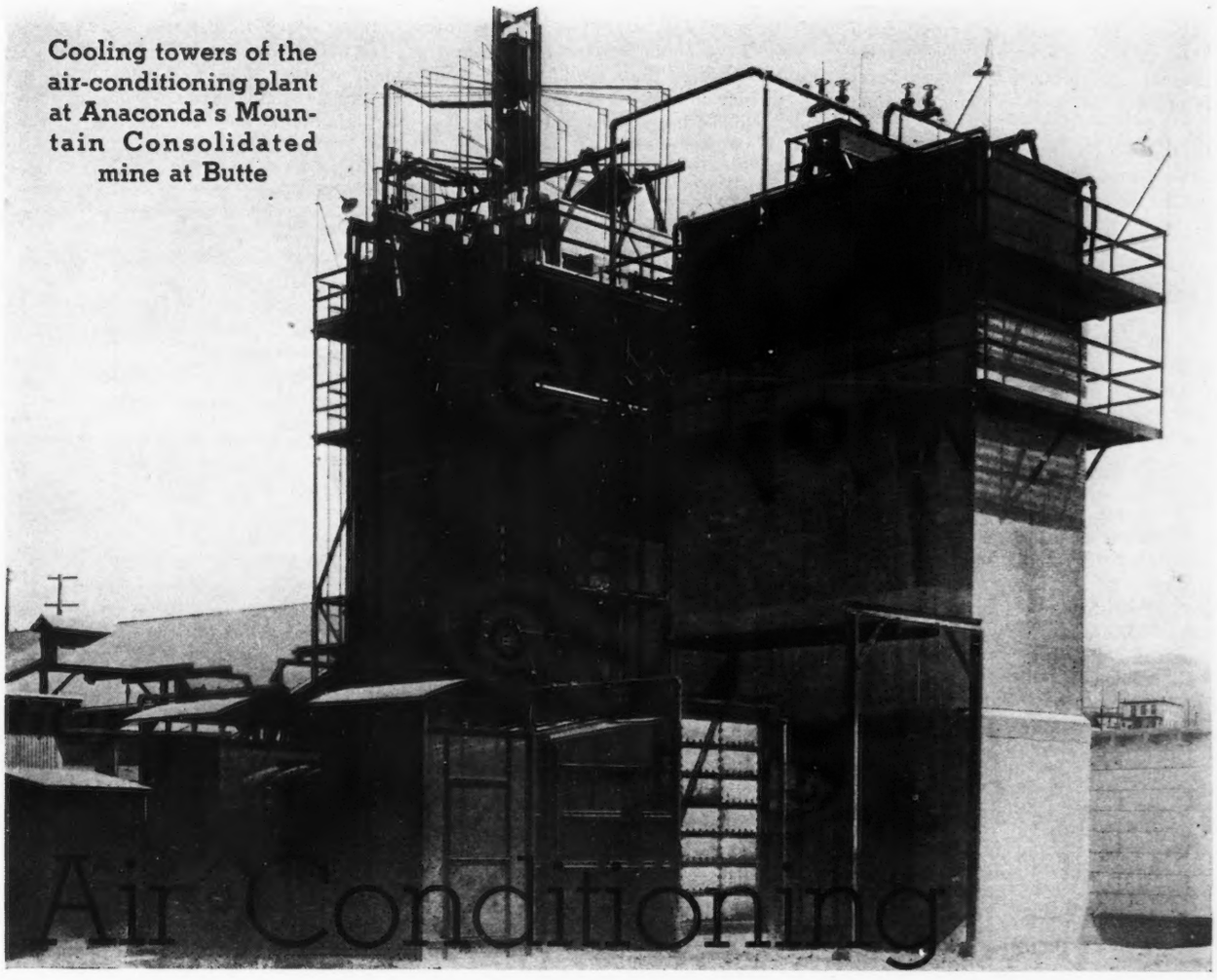
Does Placer Mining Kill Fish?

NEW LIGHT is thrown on an old controversy by a scientific study of placer mining in its relation to fish and fishing, made by Dr. Henry Baldwin Ward for the Oregon State Department of Geology and Mineral Industries, Portland, Oregon. The report, published as Bulletin No. 10, is of direct interest to mining communities and fishermen because it dispels some popular misconceptions and furnishes a scientific basis for mutual understanding between contentious groups exploiting the natural resources of the country. We commend Oregon's approach to the subject. Why wrangle in ignorance or prejudice when agreement might be reached if the facts were known?

For several years sportsmen, farmers, and recreation groups have been assuming a more belligerent attitude toward the mining industry because streams are clouded by tailings from placer and other mining operations. Charges of ruining streams and killing fish have been heard in several State capitals, and placer miners as well as mill operators have been "put on the spot." Admitting some agricultural damage in extreme cases, it seems likely that the disciples of Izaak Walton, at least, have overplayed their hand.

The controversy in Oregon pertained to the Rogue River drainage. Fishing and recreation interests charged that placer mining had ruined the area as a fishing ground, and they obtained an injunction which, but for later compromise, would have gone far to kill both placer and lode mining in southwest Oregon. Subsequently, the State determined to ascertain the facts about placer mining and fishing, and engaged an eminent scientist for the purpose. The gist of his findings, based on observations in the autumn of 1937 and the spring of 1938, is that débris from placer operations is not inimical to fish and fish life; that fish survive readily in turbid water charged only with mineral substances that do not rob the water of its dissolved oxygen; that they die of suffocation in water polluted with oxygen-consuming organic wastes; and that the conservation of fish life is primarily a matter of biological control of streams.

Undoubtedly, débris from mining and milling operations can become a nuisance that must be abated. Likewise, a crystal-clear stream can become a fetish, an object of unreasoning devotion to fishing sportsmen who demand radical control of mining operations. Probably no two débris problems are identical, and each should be solved on its merits. But we need more scientific investigation such as Oregon has made, and less popular clamor based on uninformed opinion.



Cooling towers of the air-conditioning plant at Anaconda's Mountain Consolidated mine at Butte

Air Conditioning

For the Ventilation of Butte Mines

Characteristics of local climate are turned to advantage. Air is cooled and cleaned underground close to workings

A. S. Richardson
Ventilation Engineer
Anaconda Copper Mining Company
Butte, Mont.

IN THE VENTILATION of the Butte mines the most important problem has always been the reduction of the high temperature and humidity of the air in the working places. Many sources of heat are recognized, but with the development of the mines to greater depth the constant increase in the temperature of the rock is of predominant importance.

To meet these conditions a mechanical system of ventilation has been employed, but accompanying the increase in mining depth a somewhat unusual combination of difficulties is encountered which greatly reduces the effectiveness of this method.

Because of heavy ground, the mine shafts are of small size, usually not having a clear area open to flow of air in excess of 65 sq.ft. Square-set timbering is required for support, and in many places jacket sets are needed. The resistance to air flow that is offered by these shafts is, of course, extremely high. Smooth-surfacing to reduce frictional resistance has been done wherever possible, but nevertheless there are sharp limits to the quantity of air that it is practicable to force through these mine openings.

With the increase in rock temperatures at greater depth, the heat imparted to the air passing through the inlet shafts and other main air courses is greatly increased, and thereby its capacity to improve conditions in the working places is reduced. In winter, air leaving the surface at a temperature of 20 deg. F. below zero is usually heated to a temperature of 65 deg. F. or more before it leaves the inlet shafts at stations below the 3,500 level. A further increase in the temperature of the air ranging from 5 to 15 deg. F. also commonly occurs in the crosscuts and laterals before it reaches the working zone.

Thus, in the face of an increasing demand for greater cooling capacity caused by higher ground temperatures, the increase in resistance to air flow caused by greater mining depth tends to restrict the volume of air in circulation, while the increase in the temperature of the air before it reaches the working places reduces its cooling capacity per cubic foot.

Although mechanical ventilation has been adequate to maintain good conditions in the relatively shallow mines, and also in the great majority of the

working places of the deeper mines, the need for some more effective method of coping with the higher temperatures encountered in lower level development has been evident for some time.

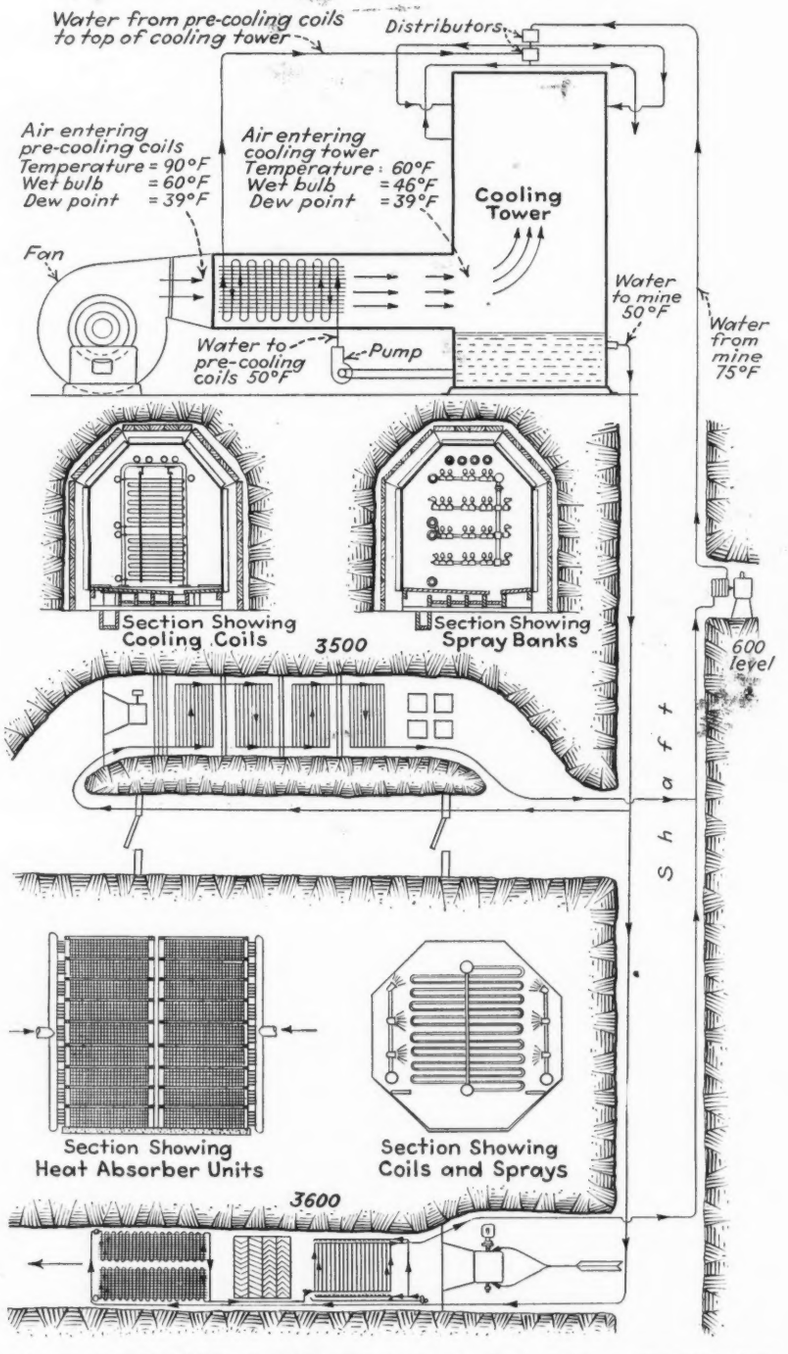
In the search for a solution to this problem an outstanding factor has been the exceptionally cold and dry climatic conditions existing in the Butte district. The average annual temperature is approximately 40 deg. F., and relative humidity during the summer months often drops to about 15 to 20 per cent. Obviously, unlimited natural cooling capacity is available at a temperature range adaptable to air-conditioning methods, and only a means of making this effective in the working zones of the mines was required.

The method of accomplishing this result that has been worked out is illustrated, diagrammatically, in Fig. 1, which shows the manner in which water, or brine, is cooled at a surface cooling tower, from which it flows through a pipe line in close circuit to an underground air-conditioning plant close to the working zone, and returns to the cooling tower through another pipe line. At the underground air-conditioning plant, heat is absorbed from the mine air into the water, or brine, circulating through the pipe system, and is subsequently dissipated in the surface atmosphere when the water is again cooled at the surface cooling tower. As the pipe lines and underground air-conditioning plants form a closed-circuit pipe system for the circulation of the water, or brine, the hydrostatic head is balanced, and power, furnished by a pump on the return pipe line, is required only to overcome frictional resistance to the flow of water.

Successful operation of this method depends on the relative heat capacity of equal volumes of air and water. In the Butte district, at the surface, the density of air is usually about 0.06 lb. per cubic foot, so that, assuming the specific heat at constant pressure to be 0.24, the heat absorbed per cubic foot of dry air, per deg. F. of temperature increase, is only 0.0144 B.t.u. In the case of water the density may be taken as 62.4 lb. per cubic foot, and specific heat at 1, so that the heat absorbed per cubic foot per deg. of temperature increase is 62.4 B.t.u. The ratio of heat absorbed per unit volume for equal increase of temperature is, therefore, 4,330 to 1 in favor of water by comparison with dry air. Of course, air passing through a mine usually removes a large amount of water in the form of vapor, and the latent heat of evaporation greatly increases the cooling effect. However, even under these conditions the relative heat capacities of water and air will be of somewhat the same order.

From this it follows that a relatively small pipe will carry a quantity of water large enough to remove from a mine more heat than would be removed by the circulation of a volume of air for which large-sized mine shafts would be required. Further than this, in the use of water as indicated there will be no increase of temperature by increase of atmospheric pressure, such as is caused by the compression of air passing through mine shafts, and as the pipe lines may be readily insulated, it may be delivered to the underground air-conditioning plant at a temperature only a few degrees above that at which it left the surface.

Experimental work on the development of this plan was commenced in December, 1930. First a small experimental plant was constructed at the surface, at which the practicability of the method was demonstrated and engineering data were obtained on which to base designs for the full-sized plants. Following completion of this work a small experimental plant was installed on the 3,200 level of the Mountain Consolidated mine, in October, 1931, to determine the effect of



THE AIR-CONDITIONING METHOD devised for the Butte mines is illustrated here. The diagram shows the simple character of the equipment employed. Compare with the photographs on page 33

the operation of such a plant on the mine workings. For this plant, however, water was supplied from the city supply system and turned to waste in the drainage system after use, in order to avoid the expense of the high-pressure return-pipe system. There being no closed-circuit system of circulation, it was impossible to gain some details of information, or to use brine, but the water supplied was cooled so far as practicable at the surface and the data gained as to improvement of mine conditions have proved to be quite reliable. Since then a number of these low-pressure air-conditioning units have been in use almost continuously, but pipe lines for closed-circuit circulation were not installed before March, 1936. At that time a high-pressure unit on the 3,500 level of the Mountain Consolidated mine was put in operation with water from the city supply system, but the cooling tower was not completed until August, 1936. A second cooling tower and an underground unit on the 3,600 level were put in operation in September, 1938.

Preliminary to the installation of these units the general plans were based on assumed ultimate requirements of cooling 250,000 cu.ft. of air per minute at the underground air-conditioning plants, the equipment to be installed as necessary. For this purpose it was estimated that it would be necessary to circulate the water, or brine, in the system at the rate of about 1,000 g.p.m. The main pipe lines in the mine shaft, and other equipment, were, therefore, made large enough for this final service condition. As the total volume of air passing through the mine is only, approximately, 120,000 cu.ft. per minute, it is necessary that a considerable proportion of the air passing through the air-conditioning plants be circulated in closed circuit, and about 75 per cent of the air passing through the existing units is being used in that manner.

In working out these general plans a number of problems related to certain features of the operation have had to be solved. Cooling of the water at the surface cooling tower is naturally most difficult during the summer months, and a special method has been worked out for use during this part of the year. Before this method is described it is necessary to recall that in any unsaturated mixture of air and water vapor such as exists in the atmosphere there are three temperatures that are indicative of the condition of this atmosphere as to heat and humidity. Highest of these is the sensible temperature which is recorded by the ordinary thermometer. Below this occurs the wet-bulb temperature, or the temperature of evaporation. Below the wet-bulb temperature is the dew-point temperature, which, as the term implies, is that temperature at which, if the air be cooled with a lowering of the sensible temperature, the water vapor in the air will commence to condense to liquid form. In the Butte district, during the summer months, the sensible temperature seldom exceeds for any length of time 90 deg. F., wet-bulb temperature 60 deg. F., and dew-point temperature 39 deg. F. Even during the month of July the dew-point temperature often passes below the freezing point.

Since the wet-bulb temperature is the temperature of evaporation, it is not possible by ordinary methods to cool water at a cooling tower below that point. Theoretical limits are seldom attained, so that assuming the water to be cooled to only 67 deg. F. at the surface cooling tower, and that its temperature be increased by 5 deg. F. in passing through the pipe line to the underground plant, it would then have a temperature of 72 deg. F., and this would be of little benefit in cooling mine air. Overcoming this difficulty was accomplished by devising a process that makes it theoretically possible to cool water to the dew-point temperature, which is often as much as 20 deg. below the wet-bulb temperature.

The main features of the equipment needed for this purpose are shown on the diagram on page 30, and are the cooling tower and a heat absorber over which the air is passed and pre-cooled before it reaches the tower. Two closed circuits of water circulation are used. In one of them the warm water returning from the mine is delivered to the top of the tower, and after being cooled falls into the sump, from which it passes through the main pipe lines to the mine and in return back to the top of the tower. In the other closed circuit, water is drawn from the sump by a pump and forced through the heat absorber in the air duct leading to the tower, and then back to the top of the tower.

To effect the pre-cooling of the air before it reaches the tower, without changing its water-vapor content, the heat absorber is constructed so that the heat exchange between air and water is effected by contact of the air with a large number of copper plates that are maintained at a low temperature. Essentially, the heat absorber is composed of a number of copper pipe coils upon which the copper plates are mounted. Water from the cooling-tower sump circulates through the pipe coils in a direction counter-current to

Table I—Operating Results at Air-Conditioning Plants

	3,200 Plant Mar. 20, 1932	3,500 Plant Aug. 24, 1936	3,500 Plant Feb. 15, 1938	3,600 Plant Oct. 16, 1937	3,600 Plant Feb. 17, 1938
Air volume, cu.ft. per min.	30,000	59,000	50,000	50,000	53,000
Intake air					
Temperature, deg. F.	81	85.5	83.0	86.0	84.0
Wet bulb, deg. F.	77	84.5	80.5	85.5	79.0
Humidity, per cent	84	96	90	98	81
Humidity, grains per cu.ft.	9.47	12.41	10.78	12.86	10.01
Discharge air					
Temperature, deg. F.	62	71	64	68	52
Wet bulb, deg. F.	62	72	64	68	52
Humidity, per cent	100	100	100	100	100
Humidity, grains per cu.ft.	6.14	8.24	6.56	7.48	4.37
Water, or brine, supply					
Gallons per minute	91	240	220	200	260
Intake temp., deg. F.	38	54	38	50	39
Discharge temp., deg. F.	69	80	65	84	74
Water removed from air					
Gallons per minute	1.72	4.46	3.78	4.8	5.4
Cooling effect, B.t.u. per min.					
Sensible heat	7 340	15,000	16,500	15,800	29,300
Condensation of vapor	16,100	37,000	31,500	40,200	44,800
Total cooling effect	23,440	52,000	48,000	56,000	74,100
Equivalent tons of ice melted per 24 hours	117	260	240	280	370

Table II—Conditions Before and During Operation of the 3,200 Experimental Plant

Place	Oct. 10, 1931 Temp.	Oct. 10, 1931 Wet Bulb	Oct. 22, 1931 Temp.	Oct. 22, 1931 Wet Bulb	Jan. 30, 1932 Temp.	Jan. 30, 1932 Wet Bulb	Mar. 20, 1932 Temp.	Mar. 20, 1932 Wet Bulb
Drift near discharge	85	83	72	70	60	58	65	64
Drift 400 ft. from disc.	93	86	86	82	83	79	79	75
Breast, 3,207 drift	97	90	93	89	82	76		
Top, 3,259 raise	90	79	83	78	75	72	73	70
Top 3,253 raise	92	86	79	72	68	65	65	63
Top 3,236 raise, return	88	81	84	72	75	72	72	68

Table III—Determinations of Particle-Size Distribution

Operating conditions	Plant Intake Number Concentration	Plant Intake Geometric Mean Diameter	Plant Intake Standard Geometric Deviation	Plant Discharge Number Concentration	Plant Discharge Geometric Mean Diameter	Plant Discharge Standard Geometric Deviation	Per Cent Elimination
Regular work period	0.62	0.33	2.18	0.36	0.25	2.38	42
Blasting period	45.55	0.30	2.96	24.67	0.36	1.78	46
Blasting period	40.91	0.35	2.43	12.26	0.40	2.36	70

the flow of air, and by contact between the pipes and the copper plates the plates are cooled. In this manner both sensible and wet-bulb temperatures of the air are lowered, but the temperature of the dew point is not changed. Water passing through the pipe coils is heated to a temperature which may approach the sensible temperature of the air, or, possibly, 30 deg. F. higher than the wet-bulb temperature originally existing in the air.

Heat Removed from Air

As heat is abstracted from the air by the water at the heat absorber, it is evident that it must be returned from water to air in the cooling tower. From this it would seem that no real advantage is gained. However, when the air is heated in direct contact with the water at the cooling tower, its water-vapor content is increased by the evaporation of some of the water. Thus the heat of the air, when raised through a given temperature range in this manner, is increased both by the change in sensible temperature and also by the latent heat of evaporation of the increased vapor content. In cooling air through the same temperature range by indirect heat exchange at temperatures above the dew point, no change in water-vapor content occurs. Thus the heat removed from the air by this indirect heat exchange is limited to that required to effect the lowering of the sensible temperature, and is considerably less than is absorbed by the air in direct contact with the water. The difference between heat indirectly absorbed from the air, and directly imparted to it with accompanying evaporation of water vapor, is then available to cool the water from the mine at a lower temperature range. The process is regenerative with dew-point temperature as the lower limit.

The tower now in use was designed to deliver water under average summer conditions at a temperature of 50 deg. F. The best performance was obtained on a day when the sensible temperature was 92 deg. F., wet-bulb temperature 62 deg., and dew point 39 deg. Under these conditions the water was cooled to 48 deg. F. During the month of July, the warmest month of the year, the average temperature of the water delivered to the mine pipe line was 48.2 deg. F.

Design of the underground air-conditioning plants has been subject to some changes, as indicated by operating experience. At early experimental units it had been found that with the lowering of the temperature and humidity of the mine air a large part of the dust carried in the air was removed by condensation of water vapor upon the dust particles as nuclei. The cumulative effect of this cleansing of a continuous large flow of air was the deposition of a film of precipitated dust on all the surfaces of the air-conditioning equipment, and this naturally tended to reduce the transference of heat from air to water.

The first high-pressure unit located on the 3,500 level is composed of four groups of parallel-flow pipe coils which are connected in series and through which the cold water is circulated in a direction counter-current to that of the air. In conection with each of the four groups of pipe coils, a separate system of water sprays is used, for which the water is circulated by a pump in closed circuit. The action of these sprays is to wash the air and to transfer heat from it to the water inside the pipe coils. After having been sprayed into the air and in contact with the pipe coils, the spray water falls into a sump, from which it is drawn by the pump and again forced through the sprays. Between each of the four groups of pipe coils there are eliminators, or baffle plates, to prevent the spray water from being blown downstream.

With the cooling and dehumidification of the air in four stages it was found that about 90 per cent of the dust by weight was removed at the first set of sprays, so that the effect of dust precipitation on equipment in the remaining three sets of sprays was relatively negligible. This has made it possible to work out some improvements in design which greatly reduce the size of the plants, and this is of considerable importance where the ground is heavy, as it is expensive to maintain large-sized openings.

Scrubbers and Eliminators

In the construction of the second high-pressure unit on the 3,600 level there has, therefore, been installed only one set of plain pipe coils with spray equipment, and in place of the other three sets of coils there has been installed a heat absorber which is similar in design to that used for precooling the air at the surface cooling tower. Between the spray chamber and heat absorber a more elaborate set of scrubbers and eliminators, or baffle plates, has been placed to remove entrained moisture and dust from the air before it passes to the heat absorber. The space occupied by the heat absorber is less than one-twelfth that occupied by the three spray chambers. Special arrangements have been made for removing any precipitated dust. but in eight months of operation this has not yet been necessary.

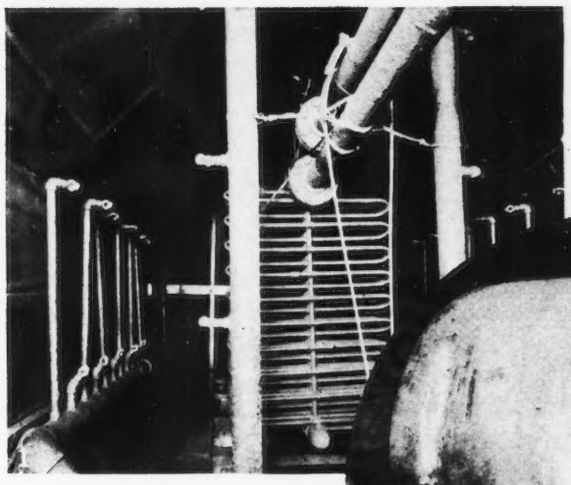
The two cooling towers now in use will be large enough to cool the full volume of 1,000 gal. of water per minute after certain changes in fan equipment have been made to supply a larger volume of air. The main pipe lines in the mine shaft are 8⅝ in. outside diameter, grade B weldless steel tubing, and are heavy enough at the bottom of the shaft to withstand a bursting pressure of 2,000 lb. per square inch with a factor of safety of 4. They are large enough to carry the full volume of flow without undue resistance, and are independently supported at vertical intervals of 500 ft. from steel bearers carried directly into the ground. Secondary distribution lines on the mine levels are 6 in. or less, as necessary, and are also designed to withstand the full working pressure with a factor of safety of 4. Both main and secondary pipe lines are insulated with 1½ in. of rock wool protected by a fire-retardant weatherproof sheet.

The plain pipe coils at the 3,500 level unit are of copper, and are of ¾-in. extra-heavy iron pipe size. The spray piping system is of ordinary iron pipe, and galvanized iron was used in fabricating the eliminators However, continued operating experience has demonstrated that it is more economical to use copper for all purposes at these plants, so as to minimize trouble from corrosion.

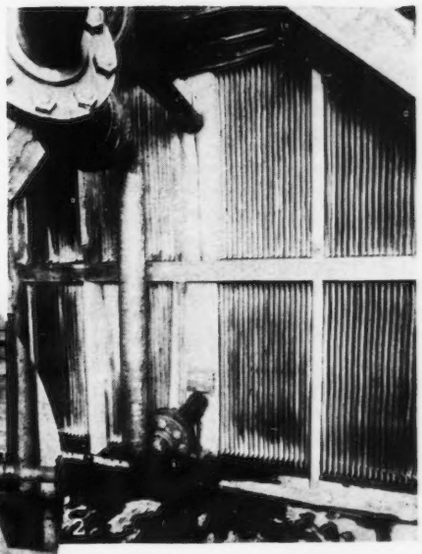
High-Pressure Plant

The high-pressure, extended surface heat-absorbers are constructed with ⅝-in. deadsoft copper tubes, 0.109 in. wall thickness, with 42 medium-hard copper sheets, 24 gage, per linear foot of tube. They are built in the company's own shop, and in making them the copper tubes are hydraulically expanded into the drilled sheets under a pressure of 8,500 lb. per square inch. This affords a factor of safety of more than 4.

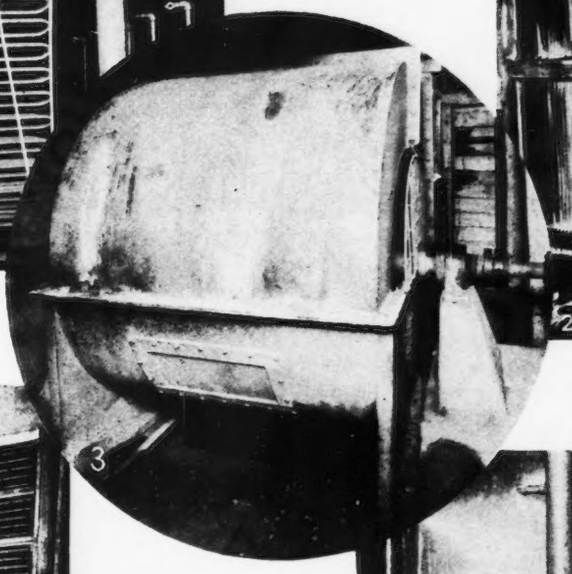
Operating results obtained at these plants are given in Table I. At the low-pressure plant on the 3,200 level these results were obtained without recirculation of water and under spring weather conditions when operating so as to produce a reduction of approximately 15 deg. F. in the wet-bulb temperature of the air. On the basis of experience at this and other experimental low-pressure units, the first high-pressure plant on the 3,500 level was likewise designed to reduce the temperature of the air by about 15 deg. F., or from 80 to 65 deg. F. on the wet bulb. With recirculation of a good flow of air in closed circuit, the lowering of temperatures in the section of the mine directly affected will result in a gradual lowering of the temperature of the air returning to the plant to a point at or somewhat below the 80-deg. F. mark. However, when this plant was put in operation it was found more advantageous to the mine as a whole to operate it in reconditioning warm air from lower level developments, so that the temperature of the air entering the plant never dropped as low as 80 deg. F., and for that reason the air



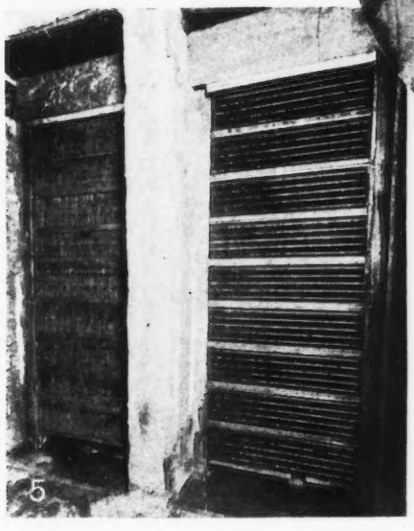
1. Spray chamber of the 3600 level unit, Mountain Consolidated mine. The water has been shut off



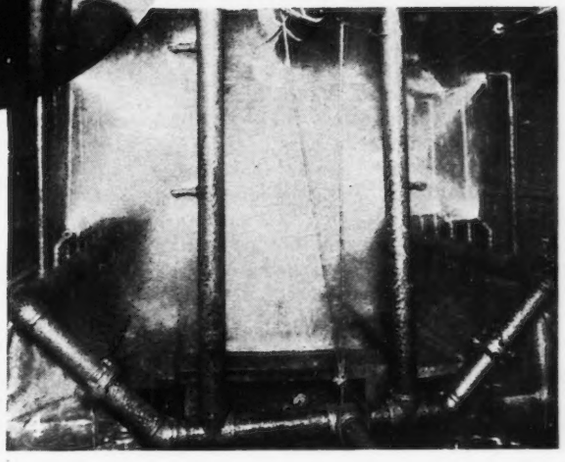
2. Scrubbers and eliminators between the spray chamber and heat absorbers in the 3600 level unit



3. The fan at the intake of underground unit, on 3600 level



4. Spraying mine air passed through chamber by intake fan. The flow is reduced to show cooling coils



5. Heat absorbers of 3600 level unit, similar in design to those used for pre-cooling the air passed through surface towers

discharged from the plant during the summer months was usually higher than 65 deg. F. In plans for the next unit on the 3,600 level the design was changed so as to lower the temperature of air entering the plant at 85 deg. F. wet bulb by 20 deg. F. The results are indicated in better plant performance and mine conditions.

With both the 3,500 and 3,600 units operating, and water circulating at the rate of about 450 g.p.m., the total cooling effect during the summer months averaged somewhat better than the equivalent of melting 550 tons of ice per day, and during the winter season in excess of 600 tons of ice per day. With the full circulation of 1,000 g.p.m., it is expected that the average annual effect will be equivalent to the melting of 1,200 tons of ice daily.

The effect on the cooling power of the air in the working places is determined mainly by psychrometer observations. The katathermometer was used some years ago, but readings obtained with it are highly variable at different air velocities, and since with intensive ventilation the velocity of air movement may vary by several hundred per cent at different positions in the same stope, the katathermometer readings are not an accurate measure.

Prior to the commencement of operation of the experimental plant on the 3,200 level, but little work was done beyond actual development, and ventilation was reduced to a minimum so as to determine the effect of the plant under these conditions. After the plant was started, stoping was done on a normal basis. The chronological record of improvement at the most important places is given in Table II. Lowering of temperature is naturally greatest at those areas nearest the discharge from the plant.

As the area affected by the first high-pressure plant on the 3,500 level had previously been cooled to some extent by a low-pressure plant having a capacity of about 50 per cent of the new plant, the change in temperature conditions effected after this plant was put in operation does not completely record the improvement effected by air-conditioning methods. The maximum improvement effected in any one place was from 90 deg. F. to 78 deg. F., and the average reduction in fourteen working places was from a temperature of 86 deg. F., 83 wet bulb, to 80.5 deg. F., 78 deg. F. wet bulb. As previously stated, the air entering the plant had a wet-bulb temperature which was usually close to 85 deg. F. instead of the 80 deg. F. for which it was designed. Also, as the rate of circulation of water was only 200 g.p.m., instead of the full load of 1,000 g.p.m., the flow through the pipe lines was slow and the increase in temperature of water between surface and plant was usually more nearly 9 deg. F. than the 5 deg. F. estimated for full operating rate. Both of these factors tended to cause the air to be discharged at a higher temperature than that planned.

In the area affected by the second high-pressure plant on 3,600 level little was done before starting the plant beyond making development openings, and only a few places were being actively worked. Most of the air discharged from the plant was coursed

downwards to the 3,800, and in return in closed circuit. The maximum improvement effected in any one place was in lowering the temperature from 94 deg. F., and 92 deg. wet bulb, to 62 deg. temperature, 62 deg. wet bulb. The general average condition for fourteen working places of temperature 90.4 deg. F., 88.2 deg. wet bulb, was lowered to temperature 76.9 deg. F., 74.4 deg. wet bulb.

With the recirculation of air from an air-conditioning plant through a section of a mine, much of the air originally supplied from the main circulation system for the ventilation of that section is liberated for the improvement of conditions in other parts of the mine. Thus, before the 3,600 unit was put in operation the average temperature of 103 working places was, during September, 1937, 87.1 deg. F., wet-bulb temperature 83.7 deg. In February, 1938, after five months' operation of the plant, the general mine average for 95 working places was temperature 78.7 deg. F., wet-bulb temperature, 75.3 deg. During this period of the year there would normally be some lowering of the average mine temperature, due to the change from summer conditions. It is difficult to estimate exactly how much the temperature of the whole mine would thus be affected without the operation of the air-conditioning plant, but on the basis of experience during the same part of the year it would probably have been about 2 deg. F.

Rock Temperatures Taken

Effect of the air-conditioning plants in lowering the temperature of the rock has, of course, an important bearing on ventilation plans. In connection with the operation of the 3,200 experimental plant an effort was made to collect data on this subject. Holes were drilled into the rock to varying depths, and cased to prevent caving. An attempt was then made to take temperatures periodically at the bottoms of the holes with maximum registering thermometers. However, the ground was so bad that the holes soon caved, and little valuable data were obtained. It is well known that both heat conductivity and specific heat of rock are low, so that a superficial cooling of the rock occurs fairly rapidly, but cooling to any great depth is accomplished only after long periods of time. As a result the rock surfaces act very well in equalizing temperature effects over short time intervals, but are of little value over longer cycles.

One June 1, 1938, the mine was shut down, and some retimbering was done in the shaft. As a safety precaution the main pipe lines for the air-conditioning plants were drained, so that the plants were put out of operating condition. Some adjustment of air flow was then made to restore the circulation through the area affected by the plants, to a large extent favoring it more than other parts of the mine. In two or three weeks the temperature in this area rose so rapidly that conditions were nearly what they were before the plants were put on operation. A survey made in July showed an average temperature of 89 deg. F., 85.4 wet bulb.

Removal of dust from mine air was measured by determining the number of particles of dust per cubic foot of air entering and leaving the plant, and also by making determinations of the particle-size distribution of the dust, in both cases in order to show whether or not only the coarser-sized particles were eliminated. An examination of the precipitated dust that accumulated in the sumps under the sprays was also made, but this material represents a residue remaining after the finer particles have passed away in the overflow of condensed water leaving the plant. Also, in this case the dust particles are probably partly dissolved in the water and form aggregates capable of giving little information as to their original condition. Attempts at dispersion were made, but it is doubtful whether complete dispersion of the aggregates into discrete particles was effected. An analysis of the size distribution of this material showed only large-sized particles bearing no apparent relationship to samples taken directly from the air.

For the determination of the number concentration of dust particles in the air, samples were taken with standard impingers simultaneously at intake and discharge of the plant. The time intervals represented in different samples ranged from five minutes to one hour, according to operating conditions, in order to get samples with a large enough number of particles for accurate counting.

Determinations of particle-size distribution were made with samples taken with the Owens jet dust sampler at a magnification of 10,000 diameters by means of an oil immersion objective and microprojector. The lower limit of visibility is about 0.2 microns.

Results of these determinations are given in Table III of values, in which the quantity, or number concentration, is expressed in millions of particles per cubic foot of air, the average size, or geometric mean diameter, being that size than which 50 per cent of the particles are less in size, and the standard geometric deviation being the ratio of that size than which 84.13 per cent of the particles are smaller to that size than which 50 per cent of the particles are smaller. The geometric mean diameter and standard geometric deviation define the logarithmic probability curve, and thus determine all average diameters.

Among other effects of the operation of the plants that are of minor importance is a drying out of the mine workings, which has some bearing on ground conditions and repair costs. Also, there is decided improvement in the quality of the air, irrespective of temperature conditions. Carbon dioxide is seldom present in appreciable proportions in the air in the actively ventilated sections of the Butte mines, and in the air-conditioned area the proportion is below the average, most tests showing about 0.04 per cent at the intake to the plant and less at the discharge. Aside from this, however, the air-conditioning process imparts a quality of freshness to the air that is distinctly perceptible at places so far distant that most of the benefit of temperature reduction is lost.

By this process of air-conditioning, with heat exchange by counter-current circulation of air and water, it is possible to cool the air to the same final temperature no matter how high its initial temperature may be, assuming only that the capacity of the heat absorbers be great enough, and the quantity of water required will remain nearly the same. This is due to the fact that the water is thus heated proportionately as the air is cooled.

Seven Years of Operation

The quantity of air circulated through a section of a mine, when the circulation is in closed circuit, is limited only by the resistance to air flow offered by the workings in that section without reference to the resistance of main inlets such as shafts, so that in a practical sense it may be increased almost indefinitely up to the limit of air velocities desirable for good working conditions.

Quantitatively, there are some limits to the cooling effect that may be derived from the water carried in a single pipe line, but, if necessary, a number of pipes may be carried in a single shaft compartment.

The air-conditioning equipment may be transferred from one part of a mine to another as necessary when different sections of the mine are worked out, or it may be moved from one mine to another. The adjustment of air flow from one section of a mine to another is not so readily made, and under certain conditions such as exist on some of the lower levels it is impossible to obtain results by this method that are comparable to those obtained with air-conditioning.

Over a period of seven years the air-conditioning plants have accomplished all the purposes for which they were designed, and have afforded a good standard of working conditions in sections of a mine where operations would have been extremely difficult without them.

PUBLIC RELATIONS for INDUSTRY

A presentation of the imperative need of mutual understanding in the conduct of our daily work

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with special reference to

THE MINING INDUSTRY

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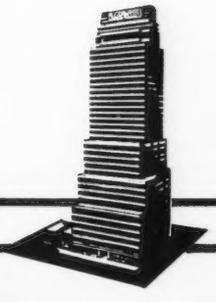
Presented by ENGINEERING & MINING JOURNAL



A McGRAW-HILL PUBLICATION

AN EDITORIAL SERVICE TO MEET

INDUSTRY'S MAJOR PROBLEM

To the readers of Engineering and Mining Journal:

● THERE IS NO DOUBT that today the American people are taking a keener, more critical interest in the conduct of business than ever before. And when I say critical, I mean exactly that. During recent years most of them have suffered loss, either of jobs or savings, and under such circumstances men are prone to accept without serious question any scapegoat that appears plausible. In the confusion of fears and resentments, they seem to have concluded that short-sighted and selfish business management is chiefly responsible for their misfortune.

However mistaken and unfair such conclusions may be, management cannot ignore them. It must recognize that in the long run, the opinions of men are the result of experience, of what happens to them each day, much more than of what they are told.

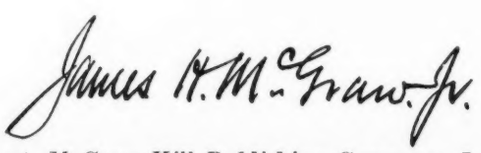
Progressive management has already faced that fact; has already begun to think and work beyond the technicalities of production and distribution that once absorbed most of its energies. It sees more clearly and deals more proficiently with its human responsibilities. It is learning to reconcile the economic success of the industrial unit with the social welfare of worker and community.

Presently, every business—the small retailer as well as the large manufacturer—must learn how to interpret more convincingly to its own public the social as well as the economic benefits of its policies and accomplishments. Only as each business satisfies the newly aroused and critical interest of people in its affairs will it be able to disarm those who trade on the human tendency to blame our troubles on someone else. Yes, if business as a whole is to win a favorable public opinion, each and every business must act to improve its own public relations.

The readers of this journal, and of other business publications, compose, we believe, a group that can achieve for American business a sound and lasting solution of this vital problem. They alone are in position to shape the working conditions of 21 million employees. They alone can mold the attitude of those other millions who compose the various "publics" to which all business must be responsible.

Heretofore, the function of business papers has been to exchange successful experience; to dig up and disseminate practical facts for the use of their readers, serving primarily the technical and merchandising needs of business. But this matter of human relations has now become of equal importance, for good industrial and public relations, it has been found, reduce corporate losses, remove fear and suspicion, promote operating efficiencies in both production and sales. A better knowledge of public relations technique is, therefore, quite properly essential for men in, or moving into, positions of greater executive responsibility.

So, beginning with this insert, each McGraw-Hill publication sets out to strengthen its editorial service in the important domain of Public Relations. I hope that the million readers of McGraw-Hill's business papers will get much real and practical help toward building better relationships between their own businesses and their employees, their customers, and the communities in which they must carry on.



President, McGraw-Hill Publishing Company, Inc.

Why a Public Relations Program

IN LESS than two generations the United States has changed from an agricultural to an industrial nation. Living standards and efficiencies at once the despair and envy of other countries have been created. Foreign delegations still flock to our shores to study our methods so that they may use them as patterns for their own organizations. Yet here at home today these methods and the systems responsible for them are under increasing attack by those who fail or refuse to comprehend our industrial economy.

Since every person employed in productive enterprise is a part of American industry, these attacks imperil the livelihood of nearly 40 million workers and their dependents. The newest addition to the payroll has as much at stake as the veteran business executive—in fact he may have even more at stake than the executive. That also is true of particular industries which at present may not be under direct fire. All industry is so interrelated and interdependent that even seemingly immune enterprises must suffer when the legitimate activities and the buying power of their customers, or the customers of their customers, are curtailed.

Ironically enough, public acquiescence in many of the current attacks is an indirect recognition of the satisfactory manner in which our industrial system normally functions. Reasonable opportunities for the employment of those ambitious to put their mental or physical talents to work, and continually rising standards of living, have come to be widely accepted as matters of course. Any unfavorable change in these conditions leaves the general public surprised, confused, and resentful. Such reactions as these make it easy for pressure groups to unloose destructive propaganda which further heightens resentments and breeds new misconceptions.

These misconceptions take many forms shaped by the experience, the inexperience, or the special interests of the critics. To one it appears that business can't manage itself and must be owned and managed by the Government. Another believes that employees are underpaid or that stockholders and executives are overpaid. To others corporate surpluses are too high. Many have convinced themselves that power and machines have reduced employment opportunities; and that industry can raise wages and reduce prices while costs go up.

Several misconceptions are based on faulty generalizations. Because a few companies have been remarkably successful, it is argued that all could make money. Because some corporations have been ruthless, all corporations, it is contended, will stoop to unethical conduct to gain their ends. This is like saying: John Smith killed Bill Brown; John Smith is auburn-thatched; all redheads, therefore, are murderers. Unfortunately, those who would indict all business for the crimes of a few are more subtle in their approach and so create an impression not in accord with the facts.

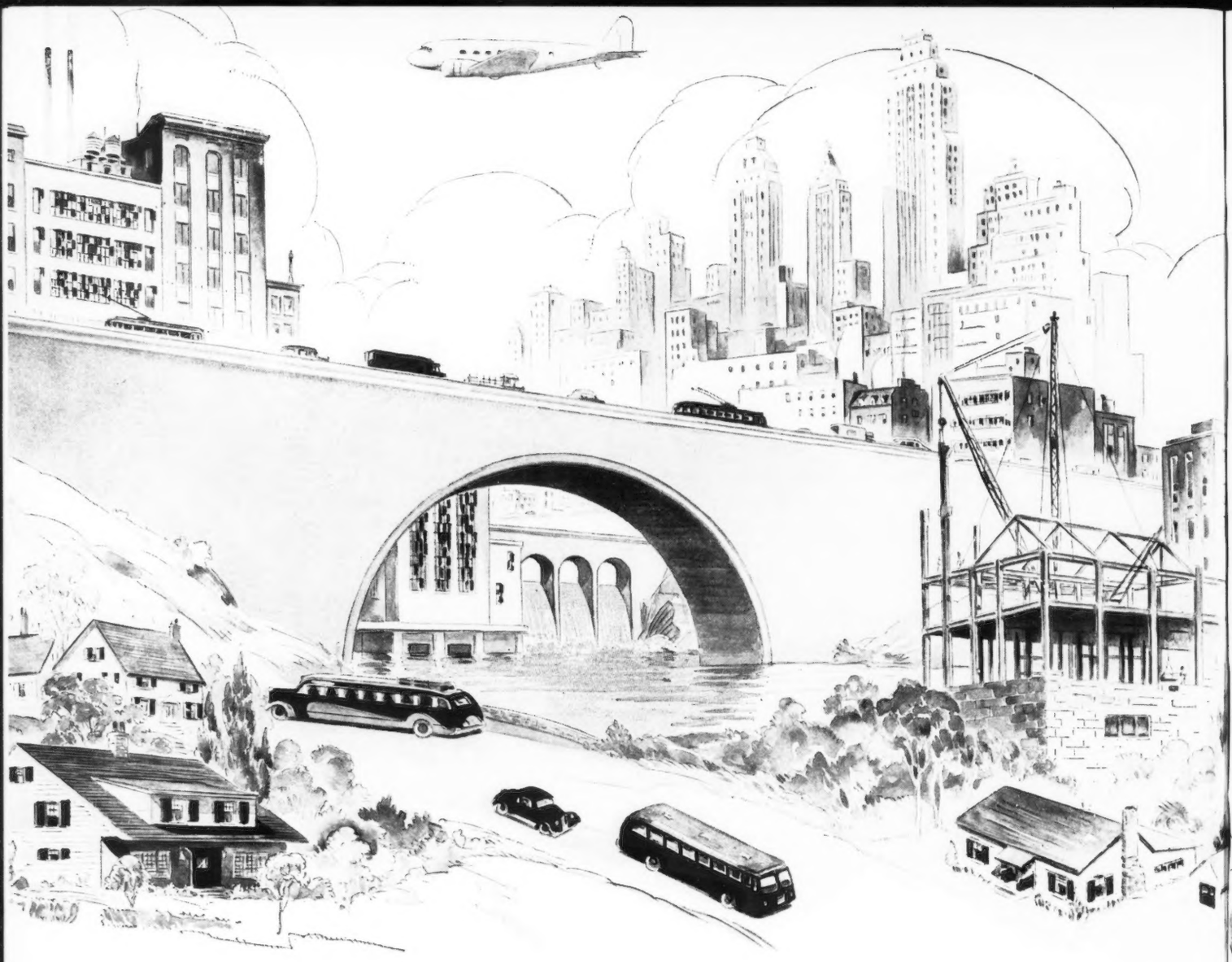
To put it bluntly, American industry, once so highly praised for its contributions to the national well-being, is now on the spot. Prevailing misconceptions of how business operates and what it does have made a field day for those who propose to hamstring or destroy private initiative and individual opportunity. These proposals run a broad gamut: They include public ownership, increasing and rigid Federal control at the expense of local autonomy, ill-conceived legislation on hours and wages, labor dictatorships, and confiscatory taxes on thrift and employment security.

Though the man in the street may be criticized for his willingness to swallow these nostrums, he is not wholly to blame. Industry, too, has been at fault, in assuming either that he was fully informed on those phases of its operations which are properly a matter of public interest, or that a healthy curiosity should be discouraged. Misconceptions multiply where the facts are hidden.

The tragedy of the situation lies in the fact that it might easily have been avoided. In the simple days of local and localized industry, everybody connected with a particular enterprise knew everybody else connected with it, and the details of its operations were an open book. The boss and the employees were neighbors; the customers, for the most part, fellow townsmen. Outside purchases were limited largely to those products which the local community neither manufactured nor raised. Competition in the modern sense was practically non-existent.

As industry developed and enlarged its field of operations, much of this early intimate personal touch was lost. The small enterprise grew bigger. In some cases combinations took in the local business and financial control passed out of the community. The local industry which still retained its identity was busy meeting increased competition and seeking to expand its distribution. Little attention was paid to changing conditions that were fostering misconceptions about the personal relations of the business. Bit by bit the close acquaintance and familiarity of the early days disappeared.

Common understanding of these things also was impeded by the greater variety of occupations as industry ex-



panded. Each man's job became so highly specialized that the old feeling of common partnership in a joint undertaking frequently was buried in an exaggerated feeling of the relative importance of his own work. This made it easy for each occupational group to get the idea that its contribution to the undertaking alone was essential and that many of the other groups were parasitic or, at best, unimportant.

Such mistaken beliefs are the exclusive property of no particular group. "Goods are valueless until sold," chants the sales staff; "without us the wheels of industry would cease to turn." The wheels would turn much faster, growls the production department, "if we didn't have so many lame-brains drawing fat salaries as salesmen." Under the cold glance of both groups, the clerical force heatedly inquires: "How long do you think this business would last if we didn't keep the cost records, send out bills, and collect the money for pay checks?" Some executives and engineers, too, have been known to forget that their plans cannot be carried out without the cooperation of other groups.

Possibly the greatest single cause of misunderstanding and friction has been fuzzy thinking on social responsibilities. Many of the responsibilities which rested on the individual or the State in our fathers' and grandfathers' days have been shifted to the shoulders of industry. New ones constantly are added or proposed—often before industry has had time to adjust itself to those which have gone before. Some of these responsibilities affect employee relations; others involve customer relations. The worker, for example, no longer is completely defenseless against the occupational hazards of his employment. "Let the buyer beware" no longer is considered smart merchandising. Many of the changes now embodied in the laws were anticipated by industry itself. Opposition—valid or otherwise—to social legislation, however, has been used to damn business in the public eye.

Fortunately, the barriers to good will and common understanding can be broken down. The process is a simple one. It consists chiefly in maintaining good policies in human relationships and in keeping all interested people—employees, stockholders and their neighbors, customers and the general public—informed. It means telling them in plain terms what revenue is received and where it comes from, what revenue is paid out and

who gets it, how an industry serves the individual, the community and other industries. Finally, it includes the acceptance of the social responsibilities which the advance of civilization imposes upon business.

Add all these things together and you have public relations.

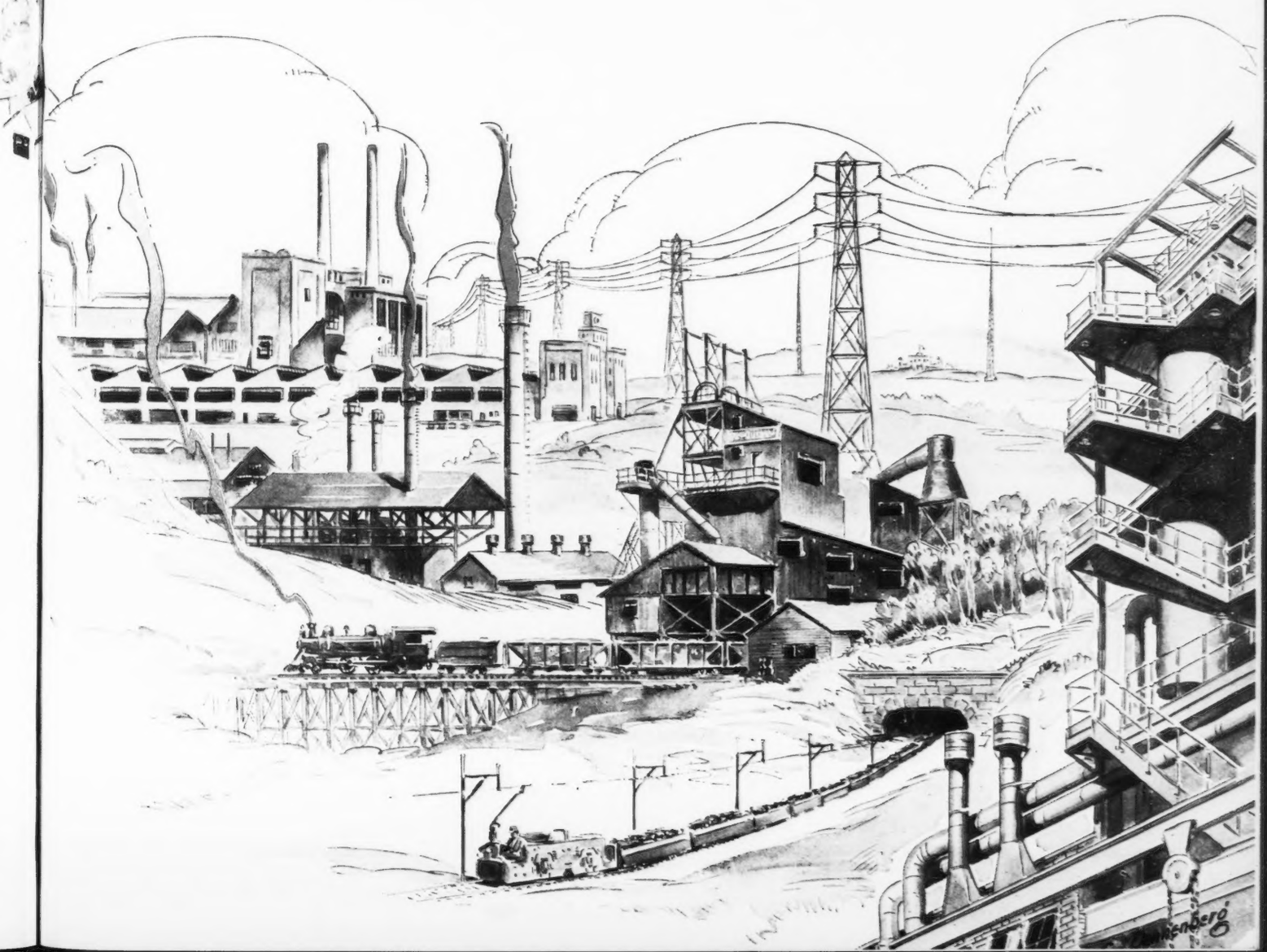
Most employers are willing to accept their social responsibilities, but they are inexpert in making that acceptance articulate. Too many employers have failed to make clear their policies, their practices, and their purposes as they relate to fair dealing with employees, investors, and the general public. Their intentions have been good, but they have cloaked them with a veil of secrecy and made a mystery out of simplicity. As a result the uninformed have been given a royal opportunity to exercise their imagination. And they have done it!

Public relations is a comparatively new activity for most business enterprises and involves a technique which too many have not yet learned. Obviously, the first place for each company to start is within its own organization. This is the "inside job" that builds a company's good name among its own family and lays the firm foundation for building public confidence and favor. As one exponent of the art phrases it: "Industry's public relations cannot be one thing and its private actions and policies something else. The two must be in complete accord."

The inside job should present no real difficulties to fair-minded employers. Most workers have a normal predisposition to view in a favorable light the organization in which they earn their livelihood. Most companies endeavor to conduct their operations so as to justify that favorable attitude. But too few of them are adept at dramatizing the facts that furnish a substantial basis for maintaining employee good will. So, where misunderstanding and suspicion born of ignorance exist, time may be required to break down the barriers that have grown up.

The task of telling this inside job to the outside world, however, will not be easy, for two reasons. First, it has been so long neglected that the backlog of misunderstanding is large. Second, public relations involves attitudes as well as actions, a viewpoint as well as an organization. Public relations is not a commodity that can be purchased like a car of coal or a bolt of silk; neither can it be sold by "canned" material. Each program to establish sound public relations must be individualized and indisputably stamped with the personality of the company promoting it. *And the deed must always back the word!*

But the task is worth the effort. For, with the inside job right, a properly conceived and intelligently executed public relations program offers business the means of counteracting successfully unjust public suspicion, unfair political attack, and unwarranted outside dictation. The need is urgent.



A Public Relations Program

EVERY MINING COMPANY should cherish a good name and reputation among its employees and in the community in which it operates. Where the company and the community are practically identical, as in an isolated camp, the company has the entire problem under its control. Where two or more companies operate in a district, they have joint responsibility for community relations. But beyond these human relations—employer-employee relations—is the larger aspect of public relations that create in the public mind a favorable or an unfavorable reputation for the mining industry as a whole—a favorable or an unfavorable impression of its social and economic services to the public at large.

Assuming that a mining company senses the importance of gaining public good will and support, it can follow a pretty well-defined technique that has been developed out of experience. The basic elements of the program are nearly identical for any industrial unit, whether it be in mining, lumbering, construction, or manufacturing. Essentially, it is a matter of maintaining a contented and effective organization and a good name. The problem resolves itself into an inside job and an outside job—industrial (or employer-employee) relations, and public relations.

Employer-Employee Relations

EMPLOYEES are a company's first line of contact with the public. To a large extent they determine its reputation in and beyond the community in which the company operates. Hence the primary importance of establishing sound relations, which can be achieved by the steps outlined below.

STEP 1—Set Up a Leader. This work needs the leadership of an able administrator, with knowledge of mining and skilled in guiding human relations. He should report to the chief executive. In a small organization this duty and responsibility may devolve upon the executive himself.

STEP 2—Clarify Organization. Uncertainty means an uneasy personnel inclined toward political maneuvering. The organization of the company should be clearly defined, so that the authority and responsibility of individuals may be known to all. In many cases, this calls for more than a simple organization chart. A manual may be necessary. Whatever is done should be adequate to make specific the lines of authority and responsibility and the functions of all officials.

STEP 3—Determine Personnel Policies. A statement should be formulated by the top executives, aided by representatives of all the management groups. If satisfactory relations have been established, the statement should be submitted to the employee representatives. Once adopted, the policies should be made known to all employees.

Policy statements should be definite in such matters as wages, working hours, overtime, promotions, layoffs, vacations, medical and hospital care, safety, training and education, profit-sharing, collective bargaining, and other matters of primary concern to employees.

STEP 4—Improve Personnel Efficiencies. Strengthen those influences within the organization that increase the efficiency of the working force, the purpose being to advance the interests of the individual and the company through lower production costs and improvements in the quality of product.

As a basis for carrying out a program looking toward increasing the efficiency of the working force, it is necessary to establish certain basic policies such as—

1—Payment of prevailing wages and salary scales.

2—Evaluation of jobs and setting up uniform scales of pay for equal grades of work.

3—Establishment of pay differentials, having due regard for responsibilities, requirements in skill, mentality, working conditions, and physical application.

4—Establishment of financial incentives where possible.

5—Establishment of positive procedures by which all changes in rates of pay are fully explained to the employees concerned. For example, where wage rates are based on metal prices.

STEP 5—Assure the Well-being of Employees. Consider the physical and mental well-being of employees by providing safe and sanitary working conditions, and services necessary for human comfort. This applies to living quarters, quality of food and cooking, heat, light, and ventilation, and suitable means for rest and recreation.

The stabilizing of employment and the establishment of organized protection against unemployment, sickness, old age, and death have a far-reaching influence on both the physical and mental welfare of employees. So has assistance to deserving individuals in their problems of savings and housing.

STEP 6—Train and Educate. A safety and first-aid program should be developed, and provision should be made for the education of children. Adult education also may be undertaken with advantage to employees, the company, and the community.

These six steps are designed to create and maintain on the part of employees a feeling of confidence in the management and satisfaction with their work and their future. This is the most important part of the "inside job" of public relations. Not only is it necessary to *do* the inside job. It is equally essential to let employees know that it is being done, not as a paternalistic gesture but as a matter of common sense in human relations.

Public Relations

HAVING DONE A GOOD JOB on industrial relations within the organization, the most important step already has been taken toward building up good will outside. The Company is now in position to tell its public not what it aspires or pretends

to be, but what it is and how it contributes to public welfare.

In the community where the company is located people judge the company by the things they are told. They may get their information from individuals or groups who are not parts of the organization and who are working for selfish ends. These people may or may not give facts. Or they may get their information from the employees themselves, who are prone to tell the truth as they know it. In promoting community good will, informed employees are an asset to the company that has done the "inside job."

A company can participate actively in building good will in the community by taking progressive steps to publicize facts about its business, making them available promptly, accurately, clearly, and frankly, through the local paper and other media that exist in every community.

A related method is to take an active and constructive part in community affairs. By becoming itself a good citizen and neighbor, a company makes itself known and liked. Here are types of community activities that have been used successfully:

1—Close acquaintance and cooperation with the local press following a policy of giving the whole truth and nothing but the truth.

2—Joining with other companies in the community to disseminate facts and to create and maintain public good will.

3—Encouraging employees to participate in civic affairs.

4—Discussing company and community affairs with local leaders of thought.

5—Participating in the operation of a community foremen's club.

6—Circulating company house organs to interested people outside the organization.

7—Presenting facts before civic organizations and clubs.

8—Showing plant operations by motion pictures in schools and before other groups.

9—Cooperating with local charities and character-building agencies.

Informing the Public

WHO COMPRISE the mining industry's public? Employees, other members of the immediate community, units of government—local, State, national—stockholders, sellers of supplies and equipment, and consumers of the industry's products. In all, quite a body of people, more or less interested and more or less influential. To keep them informed is quite a task.

Unfortunately, facts and figures of the mining industry have little circulation outside the industry itself. And yet there are many matters of public interest which, if suitably publicized, would gain good will and support for a single company or for the industry as a whole.

For example, there is probably little public appreciation of the tremendous economic and social service rendered by mining. On the other hand, there are many public misconceptions about mining that might be cleared up to the advantage of the industry.

What does the public know about the industry as an employer? What about its wages and hours? How do they compare with those of other industries? Does the public understand that one reason mining is able to pay its wage earners well is because workers are furnished the most efficient tools for production—in other words, that mechanization increases human productivity which is the sole source of workers' income? What about the industry as a purchaser of supplies and power? How profitable is mining compared with the attendant risk? How much capital has to be invested to provide a job for a man? What part do the ordinary metals play in the standard of living? These and many other similar questions suggest topics of information for public dissemination in the interest of better public relations. Part of the job can be done by individual companies, and part by State or national associations.

The foregoing outline is merely a guide or road map for those who realize the trend of current thought, and who sense the importance of the subject. The notion should be dispelled that public relations is something that can be bought and paid for once and for all. It is a mode of industrial life that must be practiced as well as preached. Neither is it something that can receive abstract approval, be delegated to some subordinate, and then forgotten. It must always be on the executive's horizon. Successful application of its principles and policies will come only with practice and experience, and the best results will be achieved in those companies whose chief executives are keenly alive to the problem.

On the Following Pages

ASSEMBLED from authentic sources, a variety of data and facts about the mining industry are presented in graphical form in the remaining pages of this insert. They answer some questions more or less prevalent in the minds of the public, of stockholders, of employees of mining companies.

How important a factor is mining in the economic and social structure of the United States? Obviously, far greater than would be indicated by the mere number of people engaged. How profitable is metal mining, and how do the companies fare that incur the risks of mining? The record emphasizes the risks and justifies the rewards. What income is produced, and how is it distributed? Wages take the major share. How do wages and hours in mining compare with those of other industries? Wages are better than in manufacturing industries, and hours are not excessive. How safe is the miner's work? The record shows a large margin for further reduction in severity and frequency of accidents.

Such facts deserve a wider public dissemination than they can receive in *Engineering and Mining Journal*. The courtesy is therefore freely extended to reproduce them in company papers, on bulletin boards, in newspapers of mining communities, or in any other manner that will promote public good will for the mining industry.

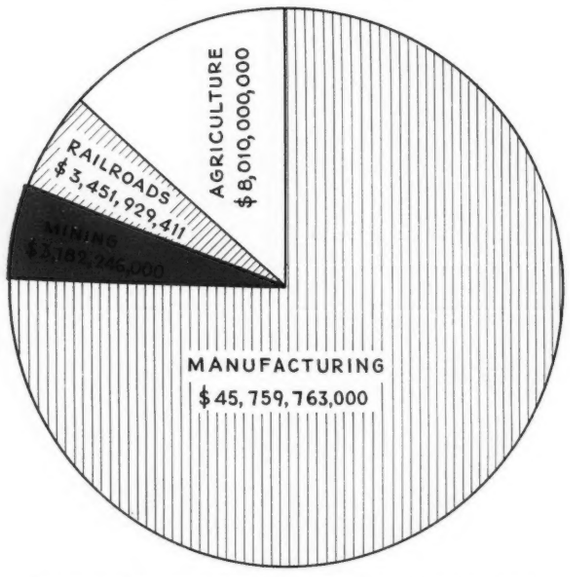
What Mining Means to the United States

MEASURED IN TERMS of capital investment, value of products, or number of workers employed, mining ranks last among the four primary industries of the United States. These conventional yardsticks, however, are not altogether accurate indicators of the importance of mining in our national economy. Actually, mining is coordinate with manufacturing, agriculture, and transportation because each of these primary industries is critically dependent upon the product of the mines. Manufacturing draws on the minerals both for its machines and for the power to operate them. The products of the mines constitute nearly two-thirds of the revenue freight handled by the railroads and about one-fourth of the ocean-borne traffic. Even agriculture now leans heavily on the minerals for its fertilizers and its implements of cultivation and harvesting. Moreover, minerals are necessary to link the farms with the markets. The products of the mines, in fact, form the material basis for modern industry. (Minerals Yearbook, 1937, Bureau of Mines.)

The accompanying graph shows the relative value of products in 1935 of the mineral industry, manufacturing, agriculture, and the revenue of Class I railroads. A similar graph for employment would show agriculture in first place, with 58 per cent of the wage earners, followed by manufacturing with 34 per cent, transportation with 5, and mining with only 3 per cent.

Among the statistical data in the table below, the reader will note the dominant position of non-metals in value of mineral products. They account for more than 45 per cent of the grand total.

RELATIONSHIP OF MINING TO AMERICAN INDUSTRY



Sources: Statistical Abstract of the United States, 1937.
A Yearbook of Railroad Information, 1937.
Minerals Yearbook, 1937, Bureau of Mines.

Mines, Employees, Production Value — 1935

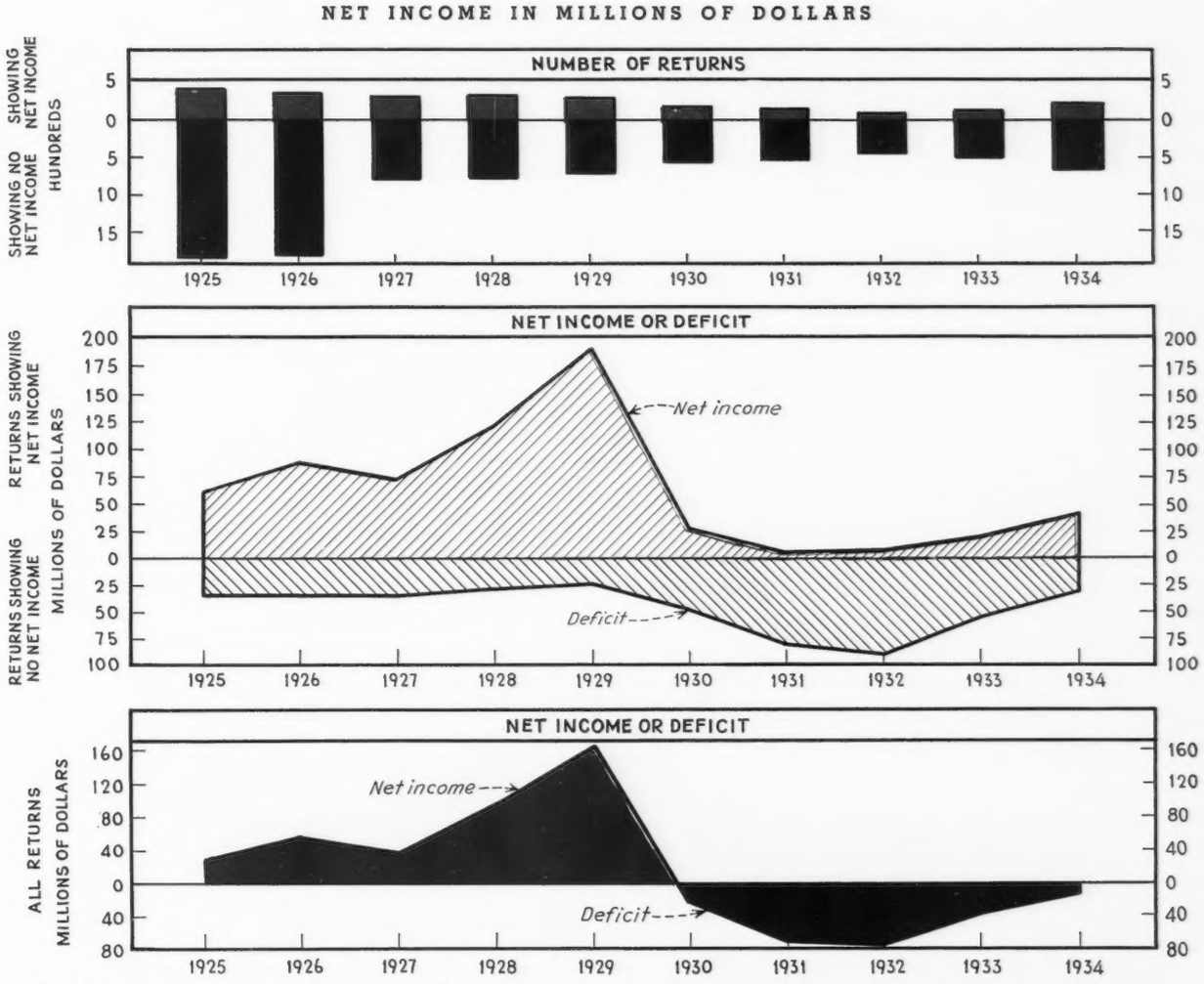
Kind of Mine	Number of Mines	Men Employed: Underground	Surface	Open Cut	Total	Product Value
Metal						
Copper	94	6,203	2,355	1,630	10,188	
Lead and zinc (Mississippi Valley)	190	5,924	626	178	6,728	
Gold, silver, and miscellaneous	9,866	32,089	17,543	3,386	53,018	
Total non-ferrous	10,150	44,216	20,524	5,194	69,934	$365,654,000
Iron	174	7,691	3,137	3,213	14,041	$358,146,000
Non-metal	495	2,498	2,360	3,481	8,339	$1,464,446,000
Metal and non-metal†	10,819	54,405	26,021	11,888	92,314	*$2,188,246,000
Coal						
Anthracite	350	77,629	20,975	4,244	102,848	$226,000,000
Bituminous	6,315	389,978	63,883	8,493	462,354	$768,000,000
	6,665	467,607	84,858	12,737	565,202	*$994,000,000
Grand totals	17,484	.....	.....	.....	657,516	$3,182,246,000

* Minerals Yearbook, 1937. (Excluding value of natural gas, natural gasoline and petroleum.) † Bulletin 410, Bureau of Mines.

Source: Minerals Yearbook 1937, and Bulletin 410, Bureau of Mines.

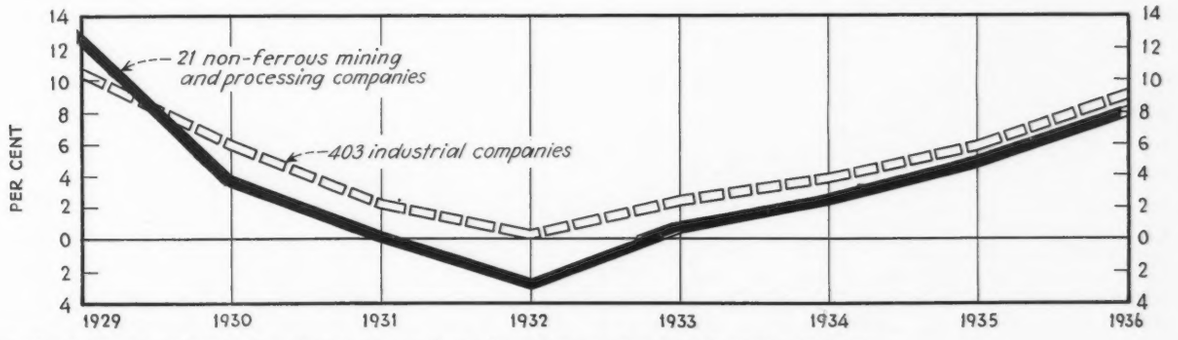
How Profitable is Mining?

CORPORATION INCOME-TAX RETURNS IN THE METAL-MINING INDUSTRY 1935–1937



All mines are not bonanzas—far from it. Each year many mining corporations report no net income. These charts show at a glance, for the period 1925–1934, the number of mining corporations in the "net income" and "no net income" groups, their respective incomes and deficits, and the net results for both groups.

Source: Statistics of Income, Bureau of Internal Revenue.



Ratio of net income to invested capital is not as large for mining as for manufacturing industries.

Source: Mineral Yearbook 1937, Bureau of Mines. Standards Statistics Co.

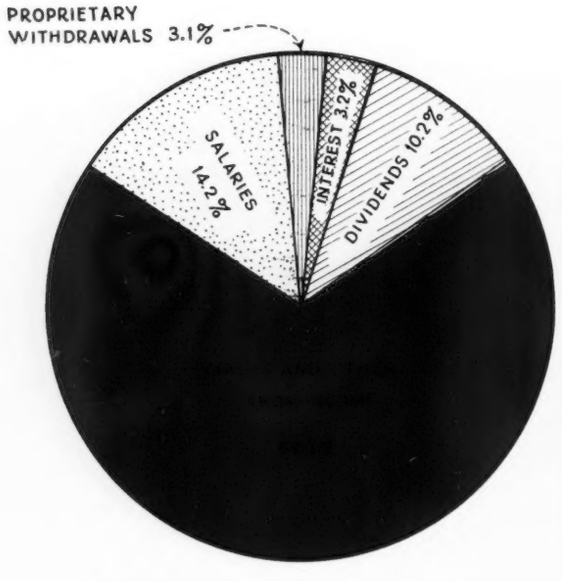
How Mining Distributes Its Income

INCOME PAID out by the mining industry may be defined as the sum of payments to, or receipts by, individuals as compensation for economic services rendered in the form of labor, management, or the furnishing of capital. If the income paid out is less than the value of the net product, or income produced, then the industry may be said to have had positive business savings. If, on the other hand, the income paid out exceeds the income produced, the industry can be said to have incurred negative business savings. The aggregate income produced or paid out by all industrial groups constitutes the national income in the United States.

Roughly two-thirds of the national income paid out represents compensation of employees. In 1935 it was 67.3 per cent, including work-relief wages to the extent of 2.5 per cent. For the same year the mining and quarrying industry (anthracite and bituminous coal, metallic and non-metallic ores and minerals, oil and gas) distributed 69.3 per cent of its income paid out as wages and salaries. Other items in the distribution are shown in the circular chart below. The bar chart shows the same data for the metal-mining industry alone for the period 1929-1934.

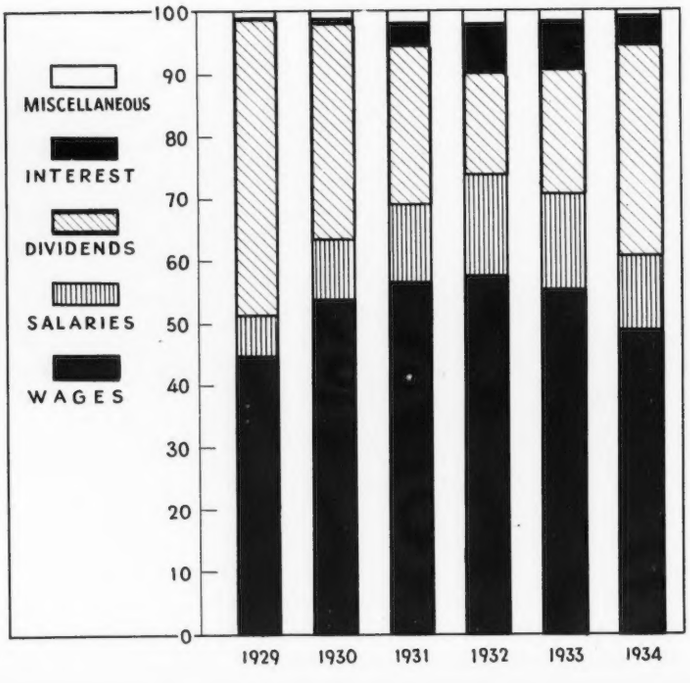
The charts on the opposite page show for comparison (1) the national income, (2) that of the mining and quarrying group as a whole, (3) of the metal-mining branch, and (4) of non-metal mining. The national income alone showed positive business savings in 1929, with annual negative savings since then. The effect of the depression on national income is clearly evident, but is much less severe than the impact on mining and quarrying as a whole, or on the metal and non-metal mining branches. Even in 1929 the mining and quarrying group and its metal and non-metal branches were drawing on capital and surplus, and negative business savings have been recorded in each succeeding year. Apparently, this is due to the rigidity of cost items other than income payments. In the metal-mining branch, which produces materials used largely in the durable-goods industries, income produced was a negative figure in 1932.

Metal mining consistenty distributes a larger percentage of income paid out as dividends than does any other branch of mining and quarrying. In 1934, for example, metal mining distributed 33.8 per cent of income paid out as dividends. The entire mining and quarrying industry distributed only 10.2 per cent; anthracite, 0.6 per cent; bituminous coal, 1.7; non-metal 26.0; oil and gas, 14.0 per cent.



HOW THE MINING INDUSTRY DISTRIBUTED INCOME PAID OUT IN 1934

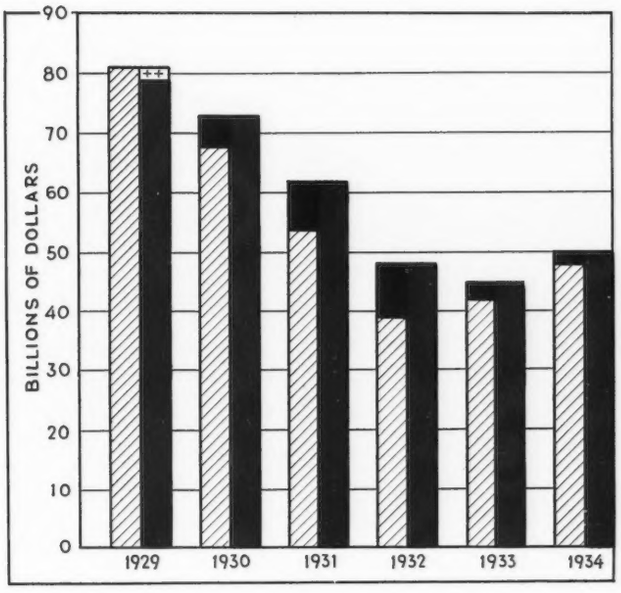
HOW METAL-MINING INDUSTRY DISTRIBUTED INCOME PAID OUT



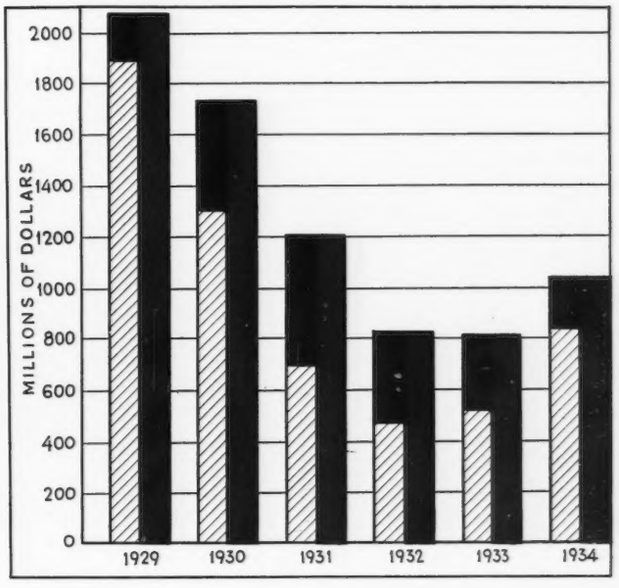
Source: National Income in the United States, 1929–1935, U. S. Department of Commerce.

Income Produced and Paid Out

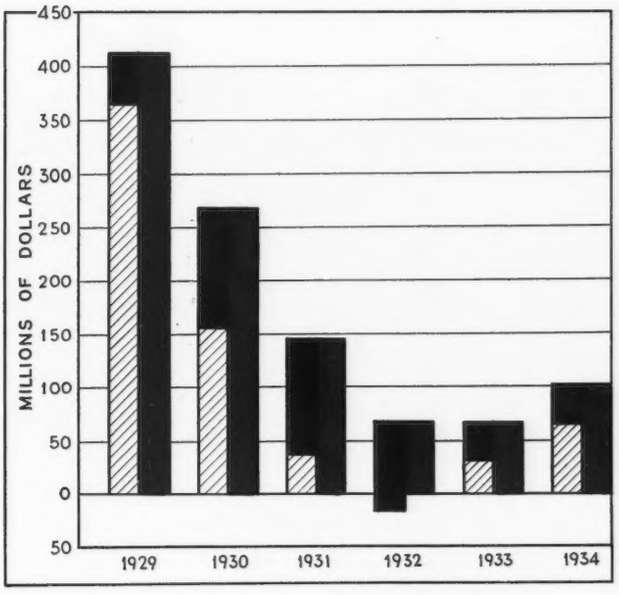
NATIONAL INCOME
PRODUCED AND PAID OUT



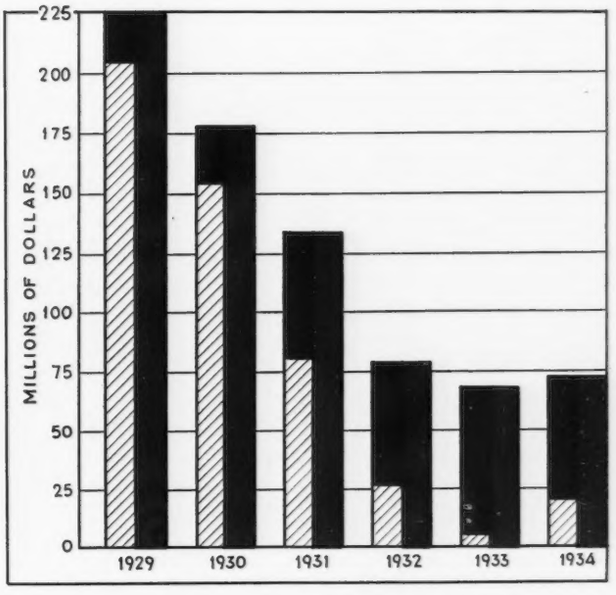
INCOME PRODUCED AND PAID OUT
MINING AND QUARRYING



INCOME PRODUCED AND PAID OUT
METAL MINING

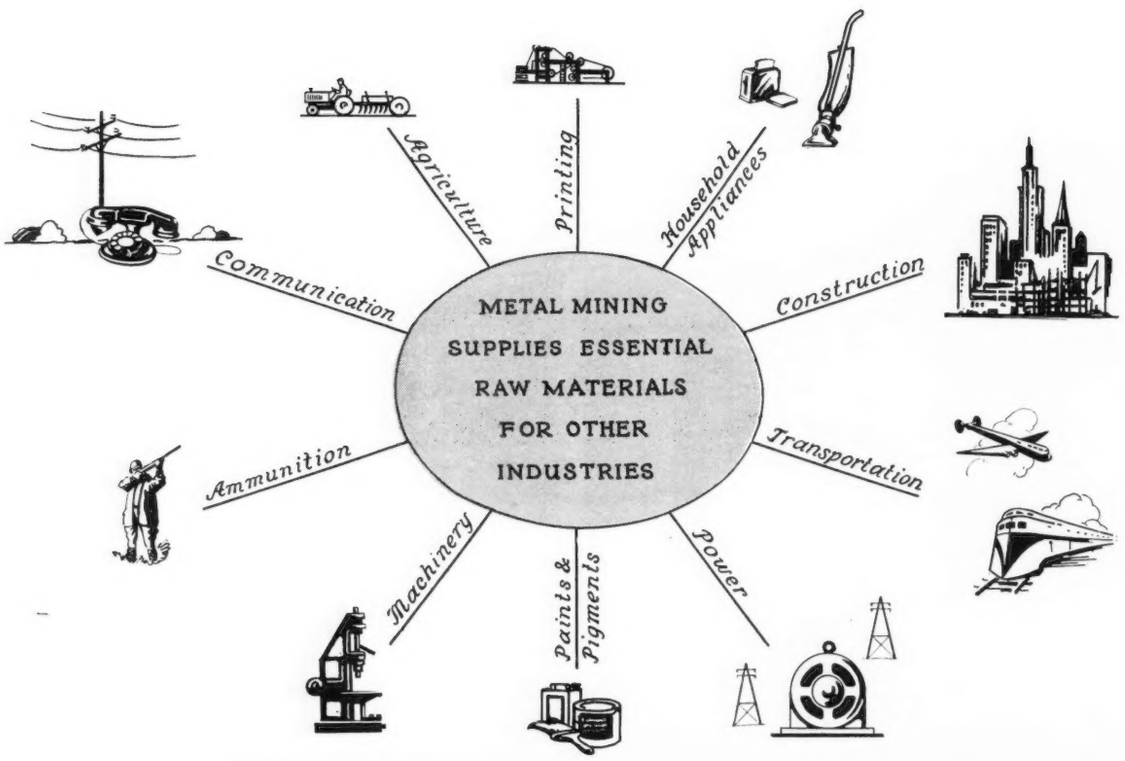


INCOME PRODUCED AND PAID OUT
NON-METAL MINING

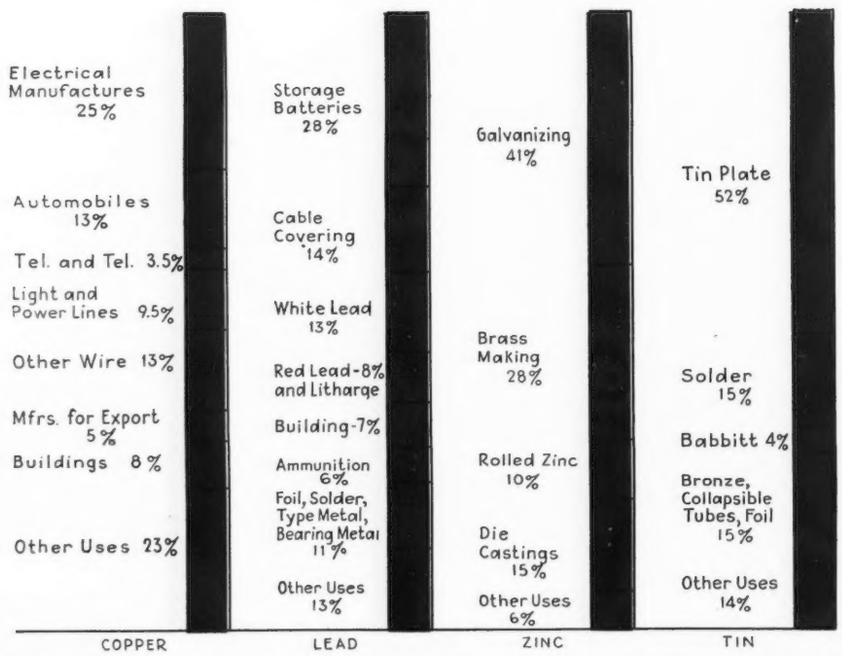


Source: National Income in the United States, 1929–1935
U. S. Department of Commerce.

Economic and Social Services of Metals



USE OF METALS IN THE UNITED STATES 1937



Source: American Bureau of Metal Statistics.

Of total non-ferrous metal consumption in the U.S.A. in 1935 the automotive industry used

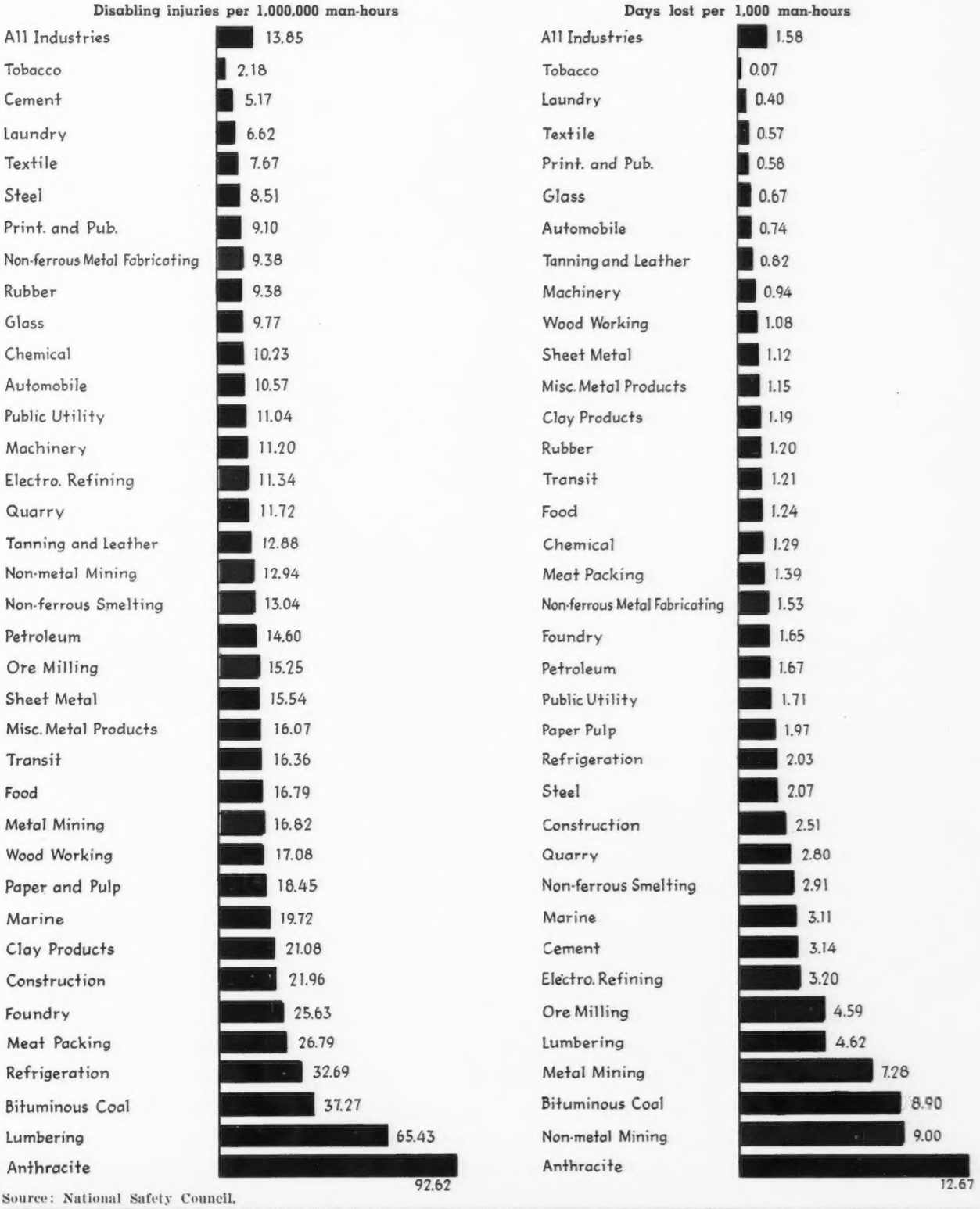
copper, 20%; lead, 37%; zinc, 16%; aluminum, 20%; tin, 13%; nickel, 30%.

Source: Automobile Manufacturers Assn.

Nearly 3,000 tons of lead—100 freight carloads—was required to make the red lead and lead chromate paints used on the Golden Gate and Oakland Bay bridges in California.

Per capita consumption of non-ferrous metals in the United States in 1937 was: copper, 13.6 lb.; lead, 8.6 lb.; zinc, 9.4 lb.

Industrial Accidents
How Many? How Severe?



Source: National Safety Council.

Wages, Hours, Employment

DESPITE the agitation for shorter hours and higher wages for workers, and fallacious theories of arbitrary wage-hour legislation, little or no criticism has been directed toward the metal-mining industry.

The eight-hour day has long been the accepted work period for underground, surface, and open-cut workers (Bull. 410, Bureau of Mines).

The cost of living has not encroached on the purchasing power of metal miners, as shown in the accompanying graph. For the period 1933-1937 the cost of living rose, but weekly earnings of wage earners in the metal-mining industry rose faster. Result: purchasing power increased; wage earners could buy more goods and services with the money they received. A similar graph for workers in quarries and non-metal mines would show almost as favorable a condition. Their purchasing power, however, did not rise above the cost of living until 1936, nor did it rise quite so high as for metal miners.

Wages of mine and smelter workers are higher, on the average, than for employees in industrial and manufacturing plants. Their earnings are high because their productivity is high. And their productivity is high because they are furnished with efficient mechanical equipment. Mining and metallurgy are "high-efficiency" industries. The graph illustrates conditions from 1933 to 1936.

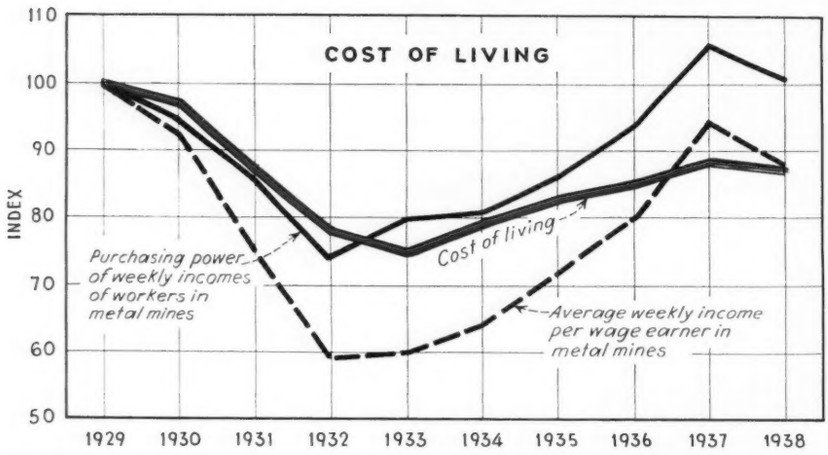
As shown graphically on the opposite page, the great majority of employees in the mining industry are wage earners and they receive the major part of all compensation for employees' services. Salaried workers are relatively few in number and receive a minor part of total compensation. The condition holds true for non-metal as well as for metal mining.

Salaried workers, however, fare better than wage earners, particularly in times of depression. Their jobs are slightly more secure, so that the percentage of this group tends to rise as total employment falls off. The same holds true of compensation. The percentage received by salaried workers tends to rise slightly as total compensation drops. But in either case—with respect to number employed or compensation received—there is fairly uniform percentage distribution between wage earners and salaried workers in good times and bad.

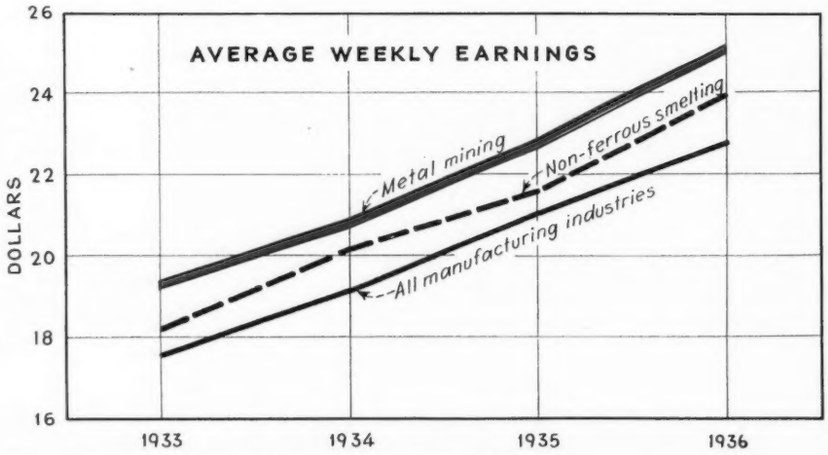
The cyclical fluctuations in employment and compensation, indicated by the relative size of the circles, give evidence of the instability of our industrial activities as a whole. When manufacture and construction are at a low ebb, the demand for metals falls off and mining activity likewise must decline. Production must be curtailed if the industry is to avoid accumulating unwieldy stocks of metal to hang over the market and influence metal prices. Thus, mining is a "dependent" industry. It must relate its production to consumption, with inevitable effect on employment.

As employment and compensation decline during a period of industrial depression, striking changes occur in the distribution of income paid out by the industry, as shown graphically on page 10. The percentage devoted to wages and salaries rises. Interest charges also go up, but the portion available for dividends to stockholders shrinks sharply. In other words, as operations become unprofitable, an increasing proportion of income paid out goes to wage earners and salaried workers. This was strikingly true in 1932, the low year of the depression, when "income produced" by metal mining was a negative figure, as shown on page 11.

The graphical data on this page and the next following pertain to roundly one hundred thousand employees in metal and non-metal mining, of whom approximately 70 per cent are engaged in the production of non-ferrous metals. They comprise underground, surface, and open-cut workers, distributed as shown in the table on page 8 of this insert.



Source: U. S. Department of Labor; National Industrial Conference Board.



Source: Bureau of Labor Statistics, Department of Labor.

Compensation of Employees

NUMBER OF EMPLOYEES

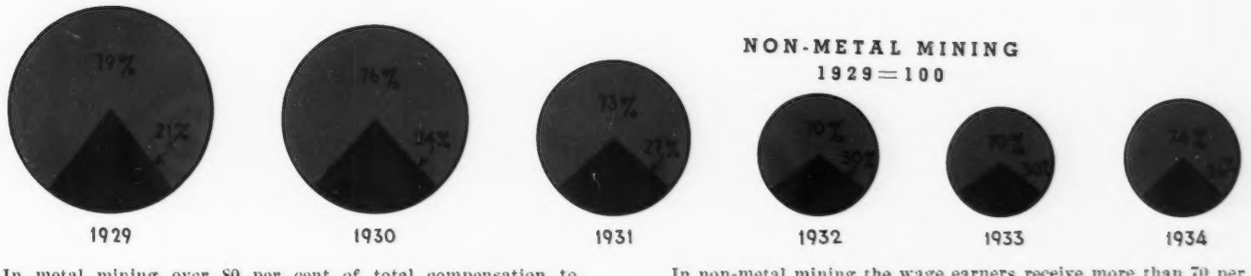
Percentage of Salaried Workers and Wage Earners

In metal mining 90 per cent or more of all employees are wage earners. The percentage drops slightly when industrial activity declines. The reverse is true of salaried workers.

In non-metal mining the percentage of wage earners is not quite so high as in metal mining. Conversely, the proportion of salaried workers is higher than in metal mining.

COMPENSATION

Percentage to Salaried Workers and Wage Earners



In metal mining over 80 per cent of total compensation to employees goes to wage earners, the remainder to salaried workers. The percentages shift as industrial activity declines.

In non-metal mining the wage earners receive more than 70 per cent of total compensation paid to employees. Salaried workers receive a higher percentage than in metal mining.

Source: National Income in the U. S., 1929–1935.

Education in Public Relations

EACH INDUSTRY'S JOB in public relations has its own peculiar requirements, depending on the nature of its public contacts. Obviously, they are not identical, for example, for food manufacture and metal mining. The former touches peoples' lives in the most intimate and direct manner, enters their homes, and affects their health and happiness. By contrast, nobody stops at the corner store on the way home to buy a pound of copper, lead, or zinc for personal consumption. Thus the mining industry is remote from the ultimate consumer of its products, despite the tremendous social and economic benefits derived from their manifold uses and the absolute dependence of modern civilization upon metals.

The primary markets of the metal-mining industry are in other industries —fabricators of equipment and supplies for construction, agriculture, transportation, communication, and limitless kinds of manufacturing operations. These metal-consuming industries constitute the customer group of the mining industry's public, aside from its employees, stockholders, and local communities. Fortunately, this customer group is well served by the mining industry with public information on production, consumption, stocks, prices, and uses of metals. This phase of the public-relations job is well done by joint agencies of different branches of the mining industry. Prominent among these agencies are: American Bureau of Metal Statistics, Copper Institute, United States Copper Association, Copper and Brass Research Association, Lead Industries Association, American Zinc Institute, Iron and Steel Institute, International Tin Research and Development Council, American Silver Producers Association, and American Mining Congress. Through these organizations the metal-using public is kept fully informed on statistical and economic conditions in the metal-mining industry.

Nor has the mining industry wholly neglected the cultivation of good relations with employees, stockholders, and local communities. These are, nevertheless, the aspects of public relations that call for unremitting thought and action, and can always be improved. They demand the study and education of executives as well as of other groups. In fact, unless trained executives become skilled in the techniques of industrial relations, unless knowledge and appreciation of the importance of the subject exist at the top, progress is likely to be slow. The process works faster by downward than by upward percolation.

For the benefit of those interested in enlarging their knowledge of the subject, we append a few of many references that can be studied to advantage. Literature on public relations is growing rapidly, and much can be learned from the published experience of others.

"The Company's Relation to Its Community." Glenn Gardiner. An address at the 1937 Silver Bay Conference on Human Relations in Industry. Silver Bay Industrial Conference Committee, 347 Madison Ave., New York.

"What Industry Can Do and Should Do About Public Relations." L. H. Brown. An article in *Sales Management,* Nov. 15, 1937, New York.

"Letter to a Utility President." R. B. Cooney. An article in *Public Utilities Fortnightly,* Oct. 14, 1937, Washington, D. C.

"Public Relations Aspects of Personnel Management." C. S. Ching. Public Relations Series No. 3, American Management Association, New York.

"Business Finds Its Voice." S. H. Walker and Paul Sklar. Articles in *Harpers Magazine,* New York, Jan.-March, 1938; also published in book form.

"Public Relations." H. A. Batten. An article in *Vital Speeches of the Day.* New York.

"Public Relations Programs Suited to the Public." American Management Association, New York. Public Relations Series No. 4.

"Public Relations." J. C. Long. A book published by McGraw-Hill Book Company, New York.

"The Way a Business Is Conducted Is Its Public Relations Program." A. O. Dietz. An article in *Executives Service Bulletin,* Feb., 1938, Metropolitan Life Insurance Company, New York.

"How to Get the Most from Public Relations." An article in *Forbes Magazine,* Oct. 1, 1937. New York.

"How Business Can Sell Itself to Shareholders." C. M. Chester. An article in *Printers Ink,* July 23, 1936. New York.

IN FUTURE ISSUES

ENGINEERING AND MINING JOURNAL will publish articles dealing with the practices of mining companies in various aspects of public relations. Through this means it is hoped that the importance of the subject will be carried to every mining company, and that the effort will result in mutual understanding among all groups concerned with the business of mining.

Important articles will deal with the safety of employees, medical care and hospitalization, recreation and housing, health and sanitation, company reports to employees and the public, and other related matters.

Believing that public relations is industry's Number One Job for the next few years, the *Journal* will endeavor to contribute something to the achievement of that end.

Determining Cut-off Grades With Triangular Coordinates

For Ores Containing Three Valuable Components

H. I. Altshuler
Consulting Mining Engineer
630 Fifth Avenue, New York

THE OPERATOR uses his assays to determine the economic value of his product. When the dollars-and-cents value of a given material is known, together with operating costs, the material can be classed as payable, or not. If large numbers of samples of material containing three valuable components are taken daily, the calculation of their values becomes an onerous task. Triangular coordinates, as will be described, may be employed as a short-cut.

Basic Principles—Though most engineers are familiar with triangular coordinates as used on phase problems, the principles involved should be reviewed in applying them to the problem of cut-off grades. The theorem from geometry which applies is:

The sum of the perpendiculars to the three sides of an equilateral triangle from any point within the triangle is constant and is equal to the perpendicular from one side to the apex of the opposite angle. In Fig. 1, DO+EO+FO=GP+HP+IP=BX

Likewise, as in Fig. 2, the sum of the lines drawn from any point within an equilateral triangle to each side and drawn parallel to the side adjacent (in a counterclockwise direction, in this case) is equal to a constant which is the length of one side. This may be derived from Fig. 1 by the use of similar triangles. Therefore, in Fig. 2, JO+KO+LO=MS+NS+RS=AB=BC=CA.

Fixed Cut-off Value and Fixed Metal Prices—For our problem, let us assume an ore carrying lead, zinc, and silver in varying quantities. Let us take a relatively high cost of $6 per ton for mining, milling, and overhead. The triangular coordinates would then show $6 worth of one metal on each leg of the equilateral triangle as in Fig. 3. If, for example, an ore shows $4 worth of lead and $1 worth of zinc, it must carry at least $1 worth of silver to meet the $6 cut-off value. This is borne out by the triangular coordinates in Fig. 3. The problem now before us is to represent the dollar value of these metals in terms of our assay report—that is, per cent of lead and zinc and ounces of silver. This is done by knowing the steps and economic results of the various stages of operation from the time of assay of the ore underground to the final settlement for the finished product. For an example let us say that the mine assay must carry a 5 per cent sampling factor, the concentrator recovers 88 per cent of the lead in a lead concentrate, and the smelter pays for 90 per cent of the lead in the concentrates at 4½c. per pound. The freight and base treatment cost is $17 per ton of concentrate, and this assays 60 per cent lead. Disregarding freight and treatment for the moment, we have: 1 per cent of lead shown by assay in the ore is worth $20\times0.95\times0.88\times0.90\times4\frac{1}{2}=67.5$c. Now, to bring in the freight and treatment charges we must find out how much to apportion to 1 ton of 1 per cent lead ore, which would produce:

$\frac{0.01\times0.95\times0.88}{0.60}=0.014$ tons of 60 per cent lead concentrate

$0.014\times17.00=\$0.238$ per ton of 1 per cent lead ore for freight and treatment. Deducting this sum from $0.675 leaves a net of $0.437 per cent lead in the original ore. Then a $6 cut-off requires: $\frac{6.00}{0.437}=13.75$ per cent lead. We may now substitute 13.75 per cent for the $6 on the lead portion of the triangle, laying out suitable divisions, such as for each per cent (Fig. 4).

Take zinc next. Using the same sampling factor of 5 per cent, 65 per cent recovered in the zinc concentrate, and smelter payment of 80 per cent of the zinc in the zinc concentrate at 5c. per pound. For freight and treatment a charge of $24 per ton of concentrate assaying 50 per cent zinc is assumed.

One per cent zinc in the ore is then worth $20\times0.95\times0.65\times0.80\times5=49.4$c. Freight and treatment $\frac{0.01\times0.95\times0.65}{0.50}\times24=29.6$c. The net for 1 per cent zinc assay per ton of ore is 49.4 minus 29.6, or 19.8c. Then a $6 cut-off requires $\frac{6.00}{0.198}=30.3$ per cent zinc. Now substitute 30.3 per cent on the zinc portion of the triangle in place of the $6 previously shown.

Finally, the amount of silver required to yield $6 is calculated. As we have allotted all the treatment charge from the smelter to the lead value in the lead concentrate, we will neglect treatment charges on the silver, using merely the various recoveries. Assume the same 5 per cent sampling factor, 90 per cent recovery with the lead concentrate, and smelter payment for 95 per cent of the commercial assay of the silver in the lead concentrate. With silver being paid for by the smelter at 64½c. per ounce, we have: Value of 1 oz. silver $= 1\times0.95\times0.90\times0.95\times64.5=49\frac{1}{2}$c. The $6 cut-off for silver requires $\frac{6.00}{0.495}=12.1$ oz. silver. To complete the triangle we may now substitute 12.1, with suitable subdivisions, in place of $6 for the silver leg of the triangle. The chart is now complete for a $6 cut-off requirement and given prices for the metals.

Let us now assume that two assay reports are received as follows:

Per Cent Lead	Per Cent Zinc	Oz. Silver
8.0	5.0	3.5
4.0	9.0	4.5

Using Fig. 4, the first assay gives a Pb-Zn intersection at A, which, traced down to the silver leg of the triangle shows that 3 oz. silver is

required to meet the $6 cut-off. Actually, 3.5 oz. are shown on the assay; therefore, the material is ore. The second assay gives a Pb-Zn intersection at *B*. The silver requirement is then seen to be 5 oz. As the assay shows only 4.5 oz., this material cannot be exploited profitably with a $6 cut-off requirement.

Variable Cut-off Values and Fixed Metal Prices—It is often desirable to use several different cut-off values within a single mine. Ore mined in a shrinkage section does not require the same value as ore mined by the use of square sets. Development muck that must be broken and possibly transported to the surface might have a very low requirement in value to be considered ore. For these reasons it might appear desirable to have several triangular charts, one for each cut-off value used at the property. Actually, it is a simple matter to construct a chart which will contain a range of cut-off values. This is done on Fig. 5, each successive triangle representing a change of $1 in cut-off value from the triangle preceding.

The highest cut-off value is given to the outermost triangle. In the example used on Fig. 5 the same figures used for Fig. 4 are repeated for the outer triangle representing the $6 cut-off value. The next step is to take a triangle one space inside and call it a $5 cut-off. An ore containing lead alone will then require for $5: $\frac{5.00}{0.437}$ or 11.45 per cent lead. Divide the left leg of the $5 triangle into 11.45 equal parts. Next, the zinc requirement will be $\frac{5.00}{0.198}$ or 25.3 per cent zinc, and the silver $\frac{5.00}{0.495}$ or 10.1 oz. silver. The zinc and silver legs of the triangle are divided into 25.3 and 10.1 divisions respectively. The same procedure is used to lay out a $4 triangle inside the $5 triangle, and so on.

After all the triangles needed have been laid out, lines are drawn connecting each per cent or ounce, as the case may be. These lines facilitate the use of the chart. Fig. 5 illustrates the use of successive triangles from $6 to $1 cut-off values. The examples shown by the dotted lines on Fig. 5 are taken with a cut-off value of $4 and an assay of 5.5 per cent lead and 5.5 per cent zinc. The chart shows that 1.0 oz. of silver is required to meet the $4 cut-off. By interpolation, the grade requirements to meet any cut-off value between $6 and $1 can be determined from a chart of this type. It represents a number of charts such as Fig. 4, telescoped into one.

Variable Cut-off Values With Variable Metal Price—The triangular coordinates are most useful when used

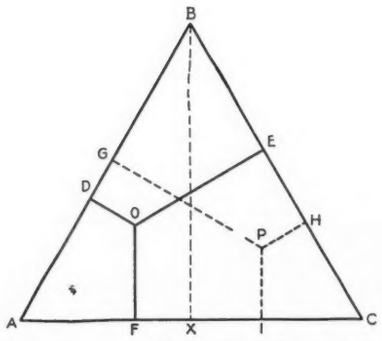


Fig. 1. . . . THE SUM of the perpendiculars to the three sides of an equilateral triangle from a point within it is constant and equal to the perpendicular from one side to the apex opposite

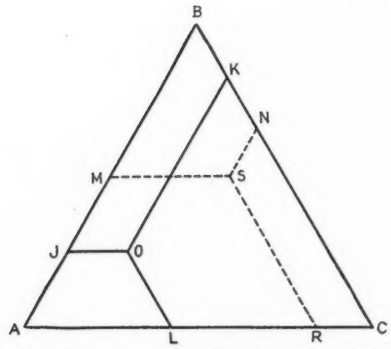


Fig. 2. . . . THE SUM of the lines drawn from any point within an equilateral triangle to each side and parallel to the adjacent side is constant and equal to the length of one side

Fig. 3. . . . CUT-OFF VALUE being fixed at six dollars, each leg of the equilateral triangle is taken as representing this amount of one of the three metals in the ore

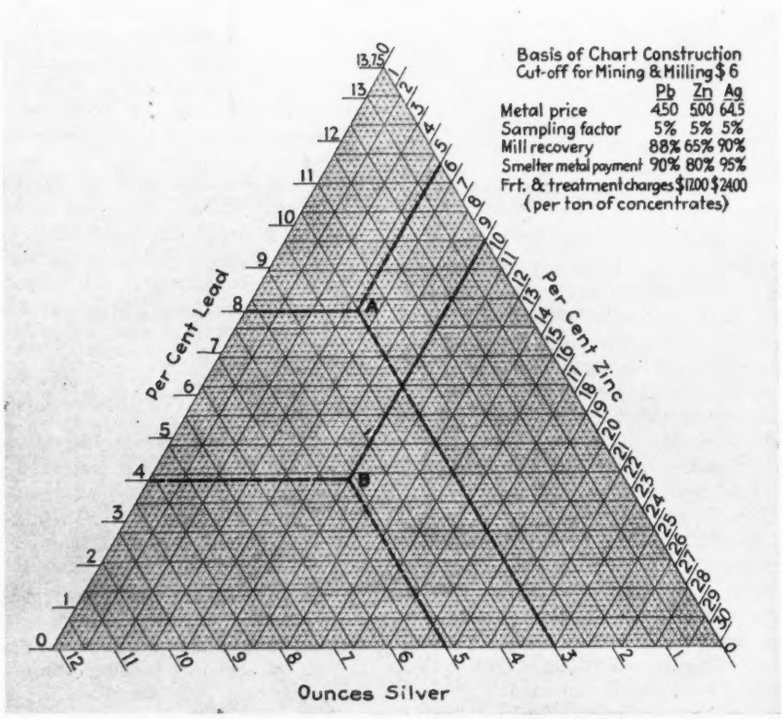


FIG. 4. . . . THE DOLLAR VALUE of each of the three metals represented on the sides of the triangle in Fig. 3 is here expressed as the equivalent percentage of that metal, after allowing for sampling error and losses in mill and smelter. The triangular coordinate paper used is reproduced photographically

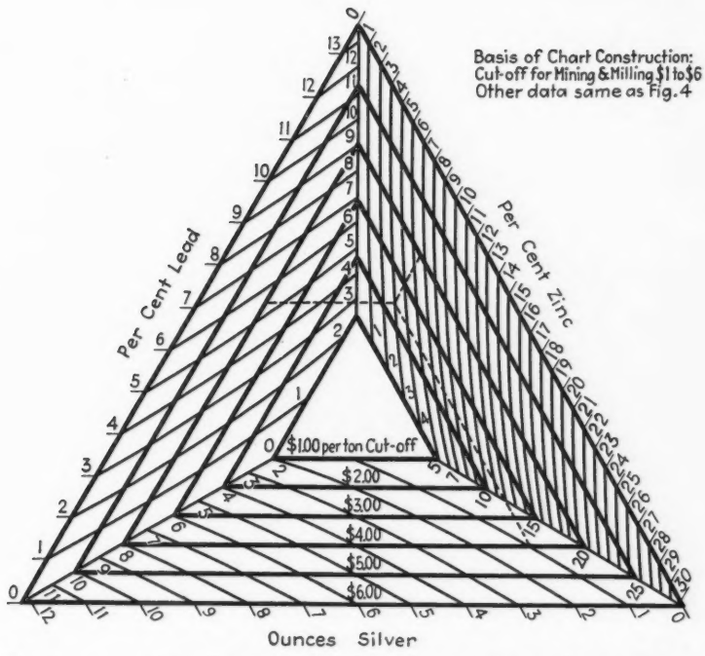


Fig. 5. . . . VARIABLE cut-off values within a definite range can be expressed on a single chart using triangular coordinates as here. The range shown is from one to six dollars inclusive. The metal prices are fixed. The triangular coordinate paper is not shown to avoid confusion

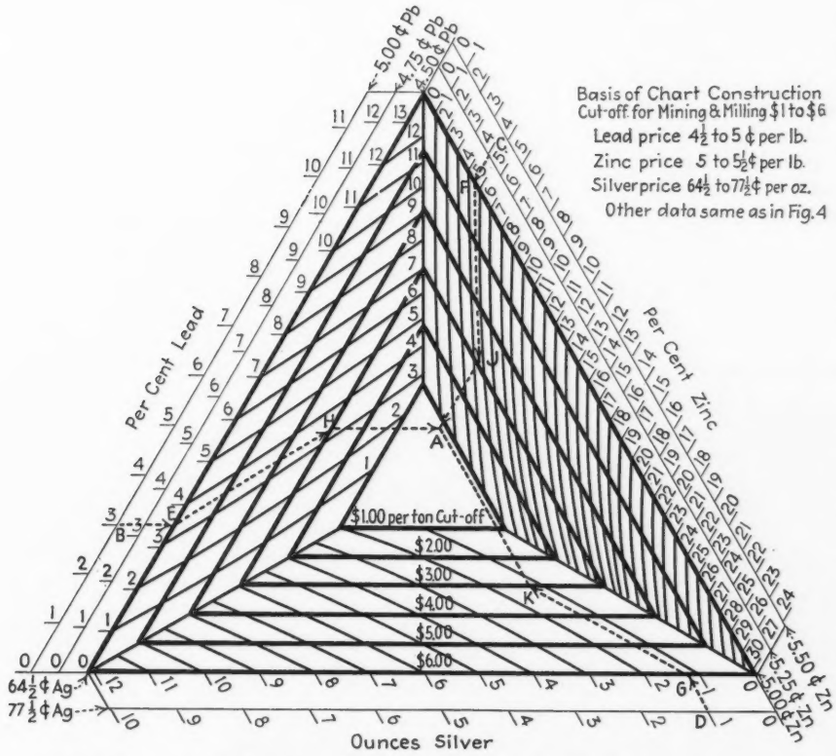


Fig. 6. . . . VARIABLE metal prices, also, with variable cut-off values, may be expressed on a single chart, as is done here. This chart has been developed from that of Fig. 5. The triangular coordinate paper is not shown

for ores containing metals subject to frequent price variations. Charts to meet this requirement are easily constructed for any range of metal prices by adding parallel scales to the legs of the triangle, each scale to represent a given metal price. Interpolations may be made between such scales as desired. Fig. 6 is such a chart developed from Fig. 5. It shows a price range for lead from 4½ to 5c. per pound, zinc from 5 to 5½c. per pound, and silver from 64½ to 77½c. per ounce.

The parallel scales are laid out at any uniform spacing from the triangle. Divisions are calculated using the cut-off taken for the outer triangle, $6 in this example. As shown previously, 67½c. was the value of 1 per cent assay of lead, before deducting freight and treatment charges of 23.8c., the 67.5c. being obtained with 4½c. lead. With 4¾c. lead, 1 per cent assay shows a value of 71.25c.; then, deducting the same 23.8c. freight and treatment and dividing this difference into $6.00 gives 12.65 per cent lead required to meet the $6 cut-off. Then 12.65 divisions are laid out on the 4¾c. scale; 11.7 per cent is calculated for the 5c. scale in a similar manner. Similarly, 27.0 per cent zinc is found necessary to give $6 with 5¼c. zinc, and 24.3 per cent with 5½c. zinc; likewise, 10.1 oz. silver is required at 77½c. silver for the $6 cut-off. Taking a given assay on one of the added scales and carrying it over to the triangle on a line parallel to the base which connects the parallel scales with the triangle, we get an equivalent assay which will give the same value with 4½c. lead, 5c. zinc, or 64½c. silver. For instance, 6 per cent lead at 5c. would yield the same value as 7 per cent lead at 4½c., and 19 per cent zinc at 5½. the same as 24 per cent zinc at 5c., and so on. The assays are located on the scale corresponding to the prevailing metal price, converted to the equivalent assay to give the same value as used for the outer triangle. This equivalent is then used on whichever cut-off triangle desired by carrying it forward to the triangle.

The example shown by the dotted lines on Fig. 6 is 3 per cent lead with 5c. lead; 4 per cent zinc with 5¼c. zinc; and 1 oz. silver with 77½c. silver. Costs are taken at $3. The lead assay at *B* is carried to the outer triangle at *E* to obtain the equivalent assay at 4½c. lead, then carried to the $3 triangle at *H* from which the usual line, as explained in Fig. 2, is drawn. This line intersects a similar line from either the zinc or the silver sides of the triangle at *A*. *C* represents the actual zinc assay, zinc at 5¼c.; *F* is the equivalent assay for 5c. zinc, upon which the triangle was based, and this assay carried forward to the $3 triangle at *J* gives the point from which to draw the zinc line which intersected the lead line at *A*. *D*, *G*, and *K* are the respective points for the silver component. In practice, two of the components shown on the assay sheet are intersected on the chart and the amount of the third component required is then determined. By comparing this figure to the actual assay of the third component, it is determined whether the material meets the cut-off requirement or not.

Adjusting Assays to Varying Extractions—So far it has been assumed that the metallurgical constants used as a basis for chart construction re-

main constant throughout the range of assays employed. This would seldom be true in practice. Therefore, it becomes necessary to adjust the assays to actual conditions before applying them to the triangular-coordinate chart. Each problem must be analyzed to determine the basis for correcting the assays of material which will not give the normal metallurgical results assumed for his chart construction.

To continue with the example of a lead-zinc-silver ore, variations in extraction might be known to exist which could be plotted on rectangular coordinates as shown in Figs. 7 and 8. The zone called "normal" would represent a combination of assays which would give the metallurgical results used as a basis for chart construction. Fig. 7 would show the percentage correction to be applied to the lead assay for other combinations, and Fig. 8 that to be applied to the zinc assay. If silver followed the lead, as is often the case, the correction obtained from Fig. 7 should be applied to the silver assay as well as to the lead. Figs. 7 and 8 are, of course, hypothetical examples, and could not be applied to any particular property. In the aforegoing examples a lead-zinc-silver ore has been assumed, but the principles outlined can be applied to any material containing three valuable components.

Figs. 7 and 8. . . . ASSAYS may be adjusted to varying extractions, where the metallurgical constants employed in making the calculations involved in constructing the charts in Figs. 4, 5 and 6 do not remain constant throughout the assays employed. In both Fig. 7 and Fig. 8 the "normal" zone represents the combinations of assays which would give the metallurgical results used as basis

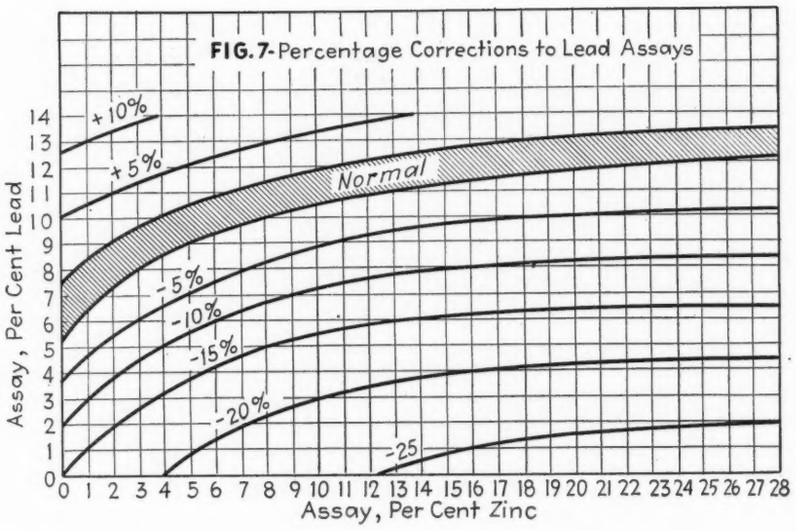


FIG. 7-Percentage Corrections to Lead Assays

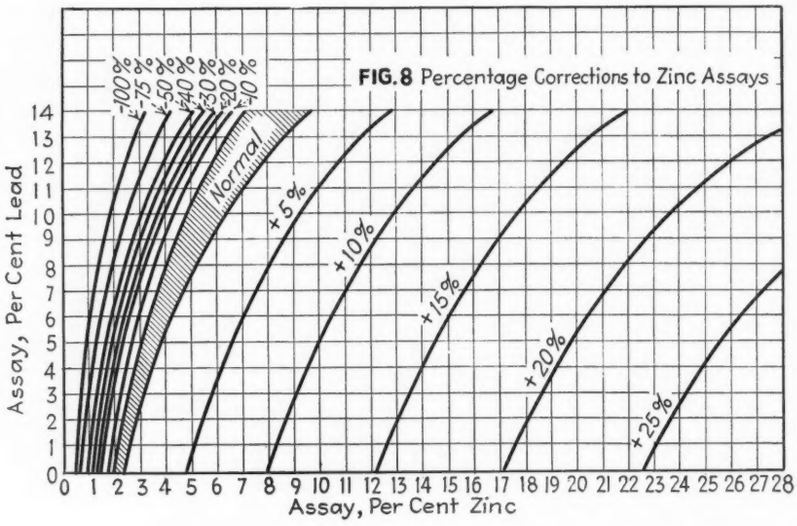
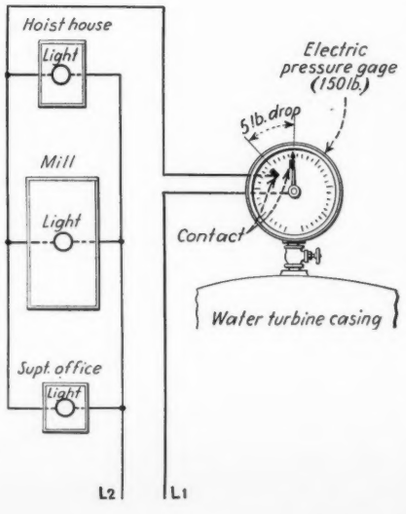


FIG. 8 Percentage Corrections to Zinc Assays

Simple Signal System Checks Water Pressure

DURING THE DRY SEASON, when the flow of water to the hydro-electric power plant supplying energy for the mine and mill is somewhat below normal, considerable care must be exercised in the matter of power distribution if stabilized plant operations are to be maintained, according to Frank J. Krazel, chief electrician, South American Development Company, Portovelo, Ecuador. For instance, heavy and continuous hoisting of ore during this period without due regard to the water situation at the power plant on the part of the hoist attendant invariably would lower the water level in the forebay, and thereby the pressure in the turbine, to such an extent as to effect a serious drop in voltage and consequent shutdown of several plant units. This meant extra work and delays, especially at the mill.



To overcome this inconvenience, it was decided to install signals at strategic points, such as the hoist house, mill, and superintendent's office, to warn the operators beforehand of any impending power shortage and consequently enable them to make necessary adjustments, as, for instance, slowing up hoisting operations, or closing down a crusher or grinding mill temporarily. This was satisfactorily accomplished with the simple arrangement shown in the accompanying sketch. Briefly, it involved the installation of a conventional electric pressure gage at the top of the turbine casing, and red alarm lights in the plant units mentioned previously. The circuit is closed and the lamps are lighted at a pressure drop of 5 lb. from normal, thus giving the superintendent or the foreman ample time to make the required power adjustment.

New Advance Scored in Boring Holes

Of Large Diameter

Improved equipment speeds work of drilling 66-in. ventilation opening at Zenith mine on Vermilion Iron Range. Almost all of the core pulled solid

GOING DOWN for another round in the 5½-ft. bore hole at the Zenith mine. The drilling equipment is already in the bottom, the power cable has been run down over the big sheave at the left, and the air hose over the little sheave just to the right of the man "cage"

▶ WIDE INTEREST WAS AROUSED *when the Idaho Maryland Mines Corporation successfully completed the boring of an 1,125-ft. hole 60 in. in diameter at Grass Valley, Calif., in 1936.* A similar though somewhat more ambitious project is now well on its way to completion in the Iron Country, and is described in the following. It has been conducted with such facility, thanks largely to improved equipment, that optimistic predictions as to the possibilities of the method employed are warranted. Unquestionably the future will see its frequent application, as conditions may permit, in place of the time-honored, laborious methods ordinarily used where openings of such diameter and even larger are necessary, whether started from surface or some underground point.*

IN THE FALL OF 1937, Pickands, Mather & Company, of Duluth, operators of iron ore mines on the Lake Superior ranges, decided that an additional connection between surface and underground workings would improve the ventilation in the company's Zenith iron mine, situated at Ely, on the Vermilion range of northern Minnesota. A borehole appeared to have several advantages over a shaft, in that it has a circular section, ideal for ventilation, and, in addition, would be cheaper and would require little or no maintenance, inasmuch as the walls would be basically strong, not having been broken by blasting. It would also be fireproof. In consequence, the company undertook to investigate the method that had been used by the Idaho Maryland Mines Corporation in boring its 5-ft.-diameter shaft at Grass Valley, Calif., two years before, with equipment devised by J. B. Newsom, under whose direction the work was done. In essentials, this equipment was a large-diameter shot drill, which, as reference to *E.&M.J.*, September, 1936, will show, was driven from a cabin supported by horizontal jacks directly above it in the hole, the combined closely coupled driving and cutting units being first lowered into position by a hoist on surface, thus doing away with the rods customarily used in shot drilling to connect cutting tool with driving mechanism and so increasing indefinitely the depth of drilling possible.

As a result of this investigation, an arrangement was entered into with the Idaho Maryland company and Mr. Newsom to drill a hole from the surface to the fourteenth level of the Zenith mine, a distance of 1,200 ft.

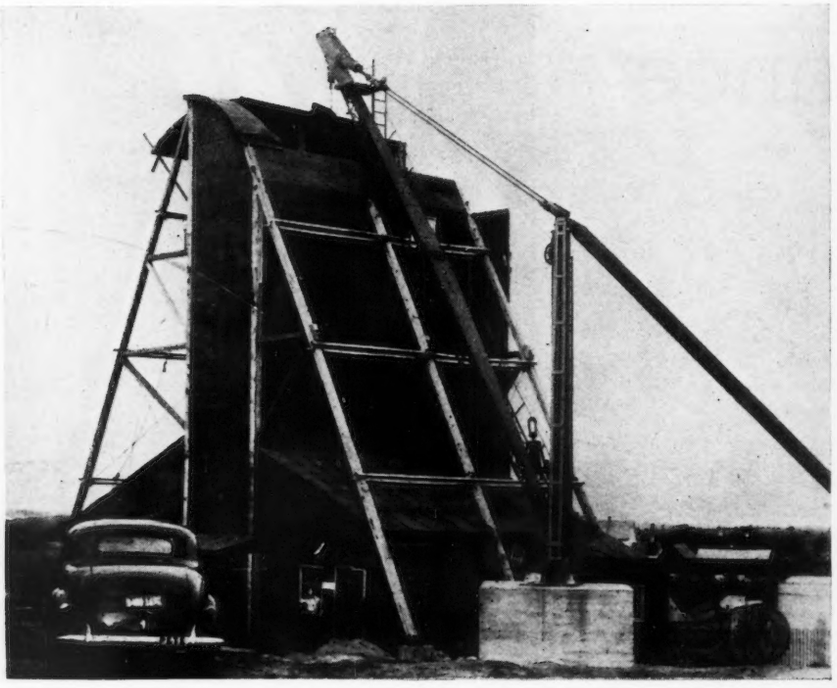
Before the work of boring was begun, however, the equipment employed on the Idaho Maryland hole was completely redesigned in the Duluth office of Pickands, Mather & Company, to take advantage of the experience gained in the course of the work done in California. Three months were consumed in this task.

As on the California job, the project was to be carried out with a two-man crew, one of whom operates the drill in the borehole, while the other handles the hoists and performs miscellaneous tasks on the surface.

The power unit provided in the steel drive cabin used on the Idaho Maryland hole had consisted of a 40-hp. motor, horizontally mounted. The experience obtained with it had shown that more power was necessary for best results. Accordingly the new cabin was designed to accommodate a 100-hp. motor. The larger dimensions of this unit demanded more room, which was supplied by mounting the motor vertically and increasing the diameter of cabin, core barrel, and cutting tool 6 in. Thus the redesigned boring equipment cuts a hole 5½ ft. in diameter instead of 5 ft., and the driving power available has been multiplied two and one-half times.

Besides the motor, the cabin accommodates the gears, the controls, the jacks, and the supply of the No. 6 steel shot (averaging 3/32 in. in diameter) used beneath the edge of the cutting tool, at the same time providing sufficient room for the single drill man who operates the controls. Cabin, core barrel, and cutting tool combined are approximately 30 ft. long and weigh approximately 15 tons. This combined unit constitutes the entire drilling device. It is lowered to its position for drilling in the bottom of the hole by a derrick and a hoist on

* Described in *Engineering and Mining Journal*, September, 1936.



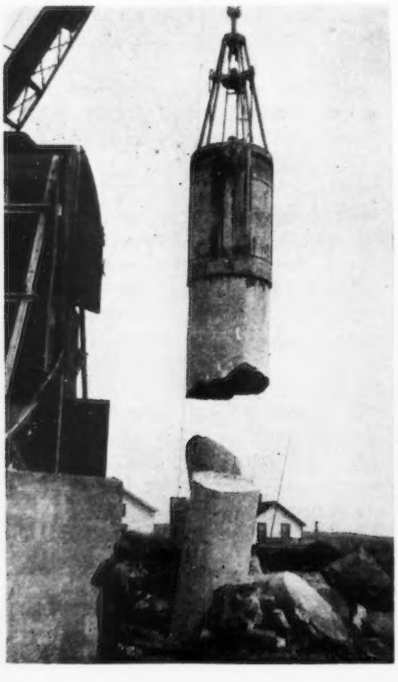
THE DERRICK BOOM is here centered over the borehole collar, which is within the housing structure

the surface, the steel hoisting rope, ⅞ in. in diameter, being reeved as a four-part line between the derrick boom and the block above the hoisting hook from which the drilling equipment is hung. This block and hoisting hook are attached, above and below respectively, to a steel disk having radially mounted rubber-covered guide wheels at and projecting somewhat beyond its periphery, so that they contact with the wall of the borehole as the disk and the drilling equipment hung below it on the hook tend to swing in the small clearance. The over-all diameter of the disk and its guide wheels is 5 ft. 4 in.

The derrick referred to was decided upon in place of the headframe used on Idaho Maryland hole, because of the greater facility afforded in handling the pieces of core. It is of the stiff-leg type and of steel, with a 60-ft. boom. As may be seen in the illustrations, the derrick stands back of the housing structure that is erected over the collar of the hole and overhangs it. Not only is it thus able to service the borehole itself, but the boom can be swung to either side to dispose of pieces of core quickly at some distance from the hole, something not possible with a headframe. The core thus set down is subsequently toppled over and hauled or pushed by a tractor some distance away from the col-

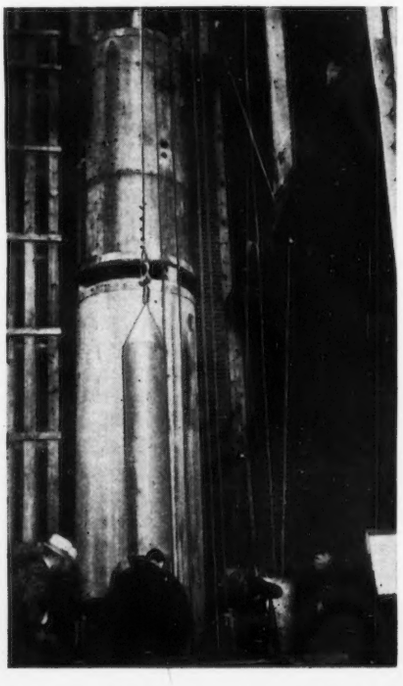
THE CORE LIFTER has just come out of the borehole bringing a great piece of the greenstone core with it. The hole is now that much deeper

ANOTHER PIECE of core is about to be set up on the ground outside the building. The core lifter will then release its grip. The derrick readily performs this task



TWO PIECES of core of medium size. Note the seam in the one at the right. E. W. Leach, manager of Pickands, Mather & Company's Minnesota mines, supplies a scale for estimating the size of the drums

THE DRILLING TOOLS, drive cabin and gear case above and core barrel and cutting shoe below, have been pulled out of the hole. The man cage hangs in front of the barrel



lar of the hole. Practically all of the core has been pulled solid, and the ground near the hole is covered with the drums of rock, of lengths varying up to as much at 14 ft.

The core lifter is similar in its essentials to that used on the earlier project, though 6 in. larger in diameter. To handle any water that may be encountered, a bailer, having a discharge valve in the bottom and 3 ft. in diameter, is also provided; likewise a metal trough at the collar for receiving the bailer discharge. This can be swung radially in any direction to dispose of the water. A muck bucket is also provided.

For handling the crew in the hole, a one-man "cage," built of sheet steel and torpedo-like in shape, was designed. Being much smaller in horizontal section than the hole, and using no guides, it can be lowered at one side of the hole, to clear the four-part line attached to the drilling equipment or core lifter if either is already in the hole. It is shown in one of the illustrations. A separate hoist handles it.

Each of the foregoing pieces of equipment that is used in the borehole is so designed that it can be hung from the hook on the end of the derrick line. When not in service it is placed to one side near the collar where it can be readily picked up.

The remaining equipment provided for boring includes a 40-cu.ft. air compressor with air hose and reel to supply fresh air to the bottom of the hole; a four-conductor cable for taking power to the 100-hp. motor in the drill cabin down the hole and a small hoist for handling it; and the two hoists for handling the drilling and accessory equipment and the man "cage."

A single-drum hoist, driven by a 200-hp. motor through a single reduction, handles the boring equipment and the core lifter, bailer, and muck bucket, using a $\frac{3}{4}$-in. wire rope. The man hoist has a single drum, winds a $\frac{5}{8}$-in. rope, and is driven by a 25-hp. motor. This hoist also handles the bailer and the muck bucket. Both of these hoists are provided with safety devices. As an additional precaution, no clutches are used. An old steam hoist drum equipped with a brake and geared with a sprocket chain to its motor suffices for handling the power cable.

Items bought new for the job included the derrick and the boring equipment, the air compressor, power cable, air line, and hoisting rope.

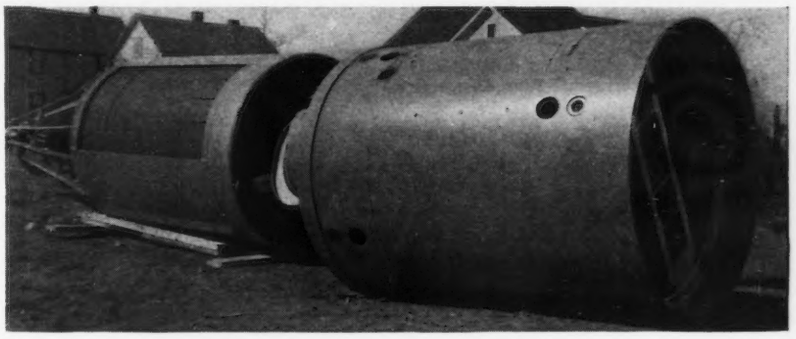
The borehole is situated in greenstone, approximately 1,200 ft. south of the Zenith workings and in the footwall. The site is such that it should be in greenstone for its full planned depth of 1,200 ft. Familiarity with the greenstone locally led the company engineers to believe that the rock bored would be practically free of seams. Surprisingly, however, practically all the pieces of core pulled down to 700 ft. have shown seams that are vertical above 400 ft. depth and dip at 60 deg. below this point. In some cases large fragments of core have separated along them when the core lifter was removed. In consequence, some difficulty was experienced with water also below the 400-ft. point.

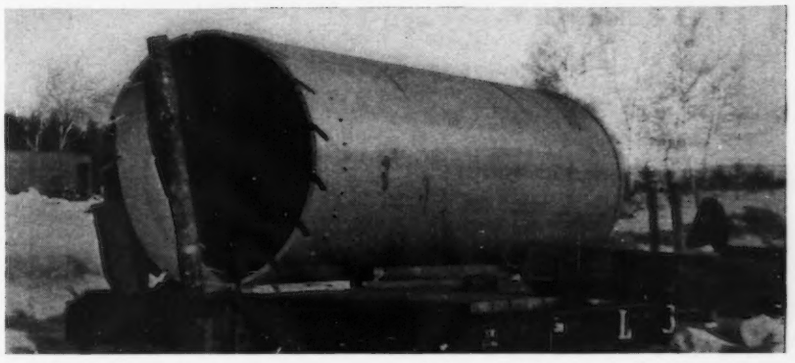
Drilling began on April 1, 1938, under the supervision of Mr. Newsom. Thanks to the great improvement in the equipment resulting from the redesigning, as well as to the previous experience of Mr. Newsom, the work has advanced rapidly, the depth attained on Aug. 1 being 694 ft. In the first month, April, an advance of 105 ft. was made, in 557 crew-hours. In May the advance was 214 ft. with continuous drilling on three shifts throughout the month. In June, trouble was experienced with water and 120 ft. was drilled. In July, the advance was 240 ft. The drilling speed is 52 r.p.m. or 900 ft./min. on the periphery of the cutting shoe. Up to the time of writing, no need for further change in design had been detected. A third factor that contributed to the excellent results obtained was the availability at the start of a nucleus of skilled men who had worked on the earlier job at Grass Valley.

Drilling and the auxiliary operations are conducted on three shifts, seven days a week. The two men of the crew on each shift divide the work between them, so that each man spends four of the eight hours in the borehole, drilling or doing other work as the case may be, and four hours on the surface, tending the hoists and doing such miscellaneous tasks about the collar as may be necessary.

The cycle of work in a 24-hr. period, when things are running well, is approximately as follows:

Cleaning bottom, 1 hr.
Drilling out core, 12 hr.
Bailing, 3 hr.
Breaking core, 2 hr.
Pulling core and setting it aside, 2 hr.
Bailing, 1 hr.
Miscellaneous, 3 hr.





DRIVE CABIN (top), minus its gear case, and the core lifter, soon after delivery at Ely. The manhole cover of the cabin can just be seen, opened, in the center of the picture. CUTTING SHOE (bottom) and core barrel—the business end of the drilling equipment—on its arrival earlier in the year. Cutting is done with chilled steel shot

The objective is to pull a round (i.e., a piece of core), and as deep a round as possible every 24 hr. The various operations are conducted in general as has already been described in the case of the Idaho Maryland hole.

Drilling speed has been found to depend to a large extent on two variables for a given r.p.m.: (1) the rate of feeding the chilled steel shot; and (2) the proportion of the total weight that is allowed to exert its effect at the contact of the cutting shoe with the rock. On the proper combination of these two variables depends the success of the work.

Electrostatic Separation—II

The Industrial Application Of the Huff Process

Herbert Banks Johnson
Vice President, Ritter Products Corporation
Rochester, N. Y.

▶ THE STORY OF HUFF *and his electrostatic separation process has never before been told in any detail. In the present article, the second of a series begun in the September issue, the author, who for years was the associate of Huff until the latter's death, describes the successful utilization of the process in the mining industry until the increasing popularity of flotation finally diverted the attention of metallurgists. The previous article gave the forty years of patent history ending with 1910, thereby providing a suitable background for the present account.*

THE FIRST Huff separators were constructed almost entirely of wood, but within a few years the construction was changed to iron and steel.

The charged electrodes were first made of glass tubing, about half an inch in diameter, in the center of which was a $\frac{1}{8}$-in. charged wire. It was believed that some insulating envelope should enclose the charged wire to distribute the charge more evenly and prevent leakage through spark discharges from the positive to the negative grounded electrodes.

Glass electrodes were soon discarded due to the high breakage in shipment and installation and also through the vibration present in most mills. Wooden-covered charged electrodes were used for about eight years. I well remember the time when the wooden-covered electrodes were ordered repeatedly by licensees in lots of 50 and 100 to replace electrodes which had punctured or burned out in operation.

This was a respectable source of income to the Huff company for several years until one operator discovered there were no new electrodes in his stock room and substituted an ordinary piece of black iron pipe. Thereafter, our electrode supply business vanished rapidly.

Tests made by the company's engineers in operating plants proved that the charge on the electrodes was a surface charge, evenly distributed, and that practically any smooth-surfaced metallic tubing could be used for electrodes. They also found that the capacity of the electrical equipment, which they were furnishing with their separators, was sufficiently large to compensate for flashes or spark discharges between the electrodes; and that the electrical equipment could be protected from any continuous discharge caused by a piece of wire or a nail wedging across the electrodes by the use of spark gaps, which also provided an audible and visible means of signalling to the operator that the machine needed attention.

Thereafter, all Huff separators were equipped with bare-metal charged electrodes and maintenance cost was reduced approximately 75 per cent.

I mention this to point out a valuable contribution to the art by a workman who had no technical knowledge —again emphasizing that "necessity is the mother of invention." It clearly demonstrates the difference between static separation, using low capacity friction or induction current supply, and electrostatic separation, using large capacity electrical equipment.

About 1907 the American Zinc, Lead and Smelting Company, of Boston, Mass., became interested in the new process development—static separation —and found that a good separation of iron and zinc table middlings was possible by this method.

Arrangements had been made to install the new Blake-Morscher static separation process when Huff learned about it and submitted his electrostatic separation process for their consideration. It was decided to make a commercial test of both methods at the mill of the American Zinc, Lead and Smelting Company at Platteville, Wis. The latter process was accepted and later Huff purchased the Blake-Morscher and other electrostatic patents which his attorneys considered it advisable to control.

The Zinc company, owning three large smelters at that time, were naturally interested in the so-called complex-ore separating problem. They were looking for a process which would remove the zinc from associated minerals in order to simplify their smelting operations, reduce penalty charges to encourage the miners and lower the cost of zinc production.

After thorough investigation the Huff process proved to be the best process available and the Zinc company purchased from the Huff company the exclusive right to the electrostatic treatment of all ores containing zinc in the United States, Canada and Mexico. The American Zinc Ore Separating Company of Denver, Colo., was formed by the Zinc company to cooperate with the Huff company in the commercial application of the Huff process in the zinc industry.

The following plants were installed and operated continuously until the expiration of the Huff patents or the conversion of the mills to the finer-grinding and flotation methods of milling operations: United States Smelting Company, Midvale, Utah; Sunnyside Mines, Eureka, Colo.; Mary Murphy mine, St. Elmo, Colo.; David Foerster mill, Ouray, Colo.; Calumet and Sonora mine, Sonora, Mexico; and several others.

Every plant installed by the Zinc company or the Huff company for the concentration of complex zinc ores was successful from the beginning and royalties of 25c. per ton were continuously paid to the Huff company for the use of the Huff process. The following data relating to the operations are interesting:

Separating power consumption for an electrostatic plant handling 100 tons daily—5 hp.

Drying cost of table middlings or concentrates—10 to 20c. per ton, depending upon fuel and labor costs.

Cost of providing a separating plant, complete, capable of handling 100 tons daily—$50,000.

Actual drying, screening and separat-

ing cost—approximately $1.00 per ton, including royalty charges.

(Note: I believe a 24-hour day is intended.)

About 150 electrostatic separators were used in the zinc industry during the life of the patents.

During this period, the Huff company made many other installations for various separations, including that of silver, iron, manganese, zircon-rutile, feldspar, graphite, mica, gold ore, and abrasives. Its separators were installed in Utah, California, Nevada, Wisconsin, New York, Vermont, Massachusetts, North Carolina, Georgia, Alabama, Missouri, Colorado, Texas, Canada, Newfoundland, Norway, Denmark, Spain and New Zealand.

The separators operated continuously under all climatic conditions, and royalties were paid regularly to the Huff company under a lease and royalty agreement which usually ended with the expiration of the Huff patents, around 1926. Many of the separators have been in operation fifteen to eighteen years and some probably are still in use.

The American Zinc, Lead and Smelting Company deserves full credit for being the first company to apply electrostatic separation commercially, successfully and profitably.

Some good operating men were developed by the companies listed above. I wish I could recall the contributions of each. Judging from the operating reports available, the royalties paid the Huff company and the fewness of the complaints received, all of them made the grade and production required at exceptionally low repair, maintenance and separation cost.

Two of the men stand out clearly in my memory. L. D. Anderson, formerly general manager of the U. S. Smelting Company's Midvale concentrator and now consulting engineer of the Potash Company of America, probably holds the record for actual tonnage separated by the Huff process. David Foerster, formerly of Ouray, Colo., doubtless is a close second.

Exclusive licenses were sold in the coal, zinc, graphite and other industries with royalty agreements, the terms of which naturally being limited to the life of the Huff patents.

During the period from 1908 to 1926, the Huff company spent approximately $500,000 in developing and perfecting the Huff process and received as license fees, royalties, etc., about $1,850,000. It was a comparatively small and highly specialized business, operating on lease and royalty agreements which naturally limited the field of application to the treatment of the more valuable minerals.

The flotation process appealed strongly to the mining industry. It promised simplified milling operations, higher recovery of values through finer grinding and elimination of dust and slime nuisances. The flotation process provided a real boom to machinery and equipment manufacturers interested in the handling or rock, ore and similar materials. It speeded up the development of ball mills, rod mills, pebble mills and tube mills for fine grinding; classifiers, settling tanks, thickeners, filters and dryers.

These equipment manufacturers directly or indirectly were financing the application of the flotation process. Several well-known engineers have estimated that at least $25,000,000 has been spent during the past twenty years by these combined equipment manufacturers, reagent manufacturers and mining companies in adapting the process to their problems.

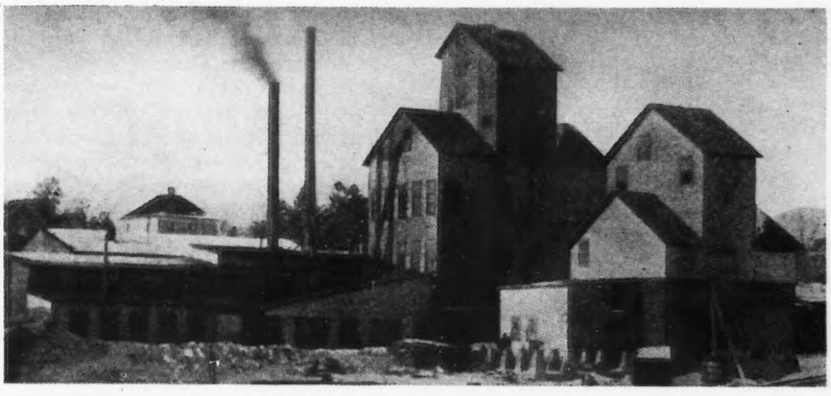
Manufacturers of jigs, tables, magnetic and electrostatic equipment were soon in the same position as manufacturers of B battery radio sets found themselves after the electric radio was introduced and perfected. Their market was greatly curtailed and sales competition multiplied. The companies who had a diversified production survived, while companies like the Huff company, who were specializing in one process, could not carry on at a profit. The latter company had to protect its exclusive licenses, lease and royalty agreements. Therefore, all equipment had to be leased and could not be sold outright which was considerably of a handicap in expanding sales. The application of the process, therefore, was limited largely to the business methods adapted by the company rather than the merits of the process itself.

It is interesting to note, however, in reviewing the development of such an important art, so well protected by patents, that the company had no difficulty whatever with its licensees other than one patent interference which was of no consequence. There were no infringement suits, no damages paid and no question of the validity of the Huff patents.

When Charles H. Huff died in 1915, I was advanced from manager to president of the company by election of the directors. For reasons cited above, in 1926 when most of the license agreements limited to the life of the Huff patents expired, we decided to sell the remaining license agreements to the licensees and liquidate the company for the best interest of the stockholders.

Flotation was in vogue and, regardless of the expensive patent litigation involving the basic process, sales activity was widely distributed through manufacturers of several types of flotation cells as well as manufacturers of auxiliary equipment such as grinding mills, classifiers, thickeners, etc. Probably 95 per cent of new concentrating plants put into operation selected the flotation process as a means of separation.

(*Continued on page* 52)



TWO VIEWS showing plants that formerly employed electrostatic separation in concentrating ores. Above, the United States Smelting company's mill at Midvale, Utah. Below, the concentrator of the American Zinc Ore Separating Company, at Platteville, Wis.

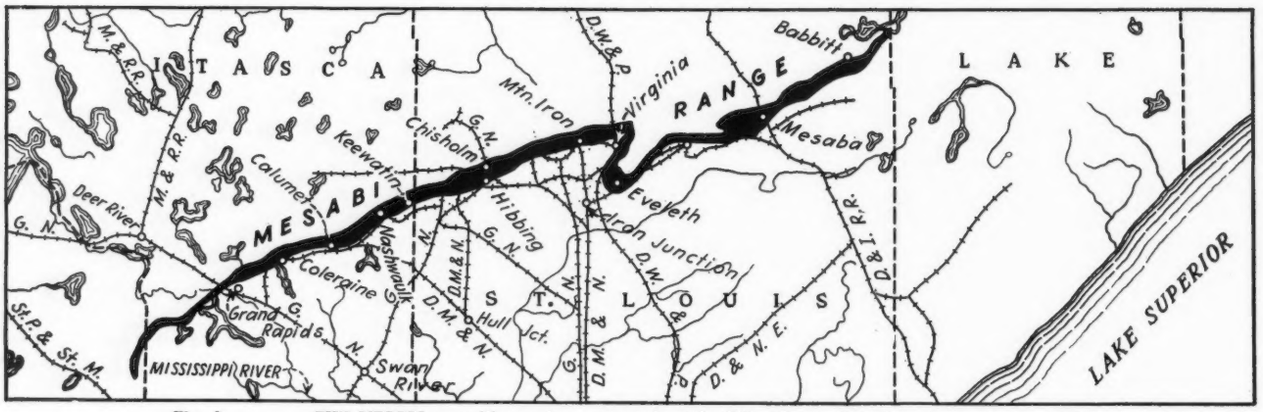


Fig. 1. . . . THE MESABI runs like a river, approximately 100 miles in length and varying in width

Open-Pit Transport

On the Mesabi Range

I

Some installations that illustrate the manner in which the problem is being treated as pits deepen and other working conditions change

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BEFORE entering on a discussion of the ore haulage systems in service on the Mesabi range in Minnesota some facts about the range itself will help the reader to understand why the haulage problem is engaging the attention of the iron-ore operators. As may be observed on the accompanying map, the Mesabi runs like a river approximately 100 miles in length and varying in width through the northern portion of the State in a direction that is generally northeast-southwest. The qualities and kinds of iron ore vary as much as the widths of the deposits, consisting mostly of soft hematites and limonites that change in texture from fine to coarse and granular and range in depth from grass roots to 300 ft. Near Keewatin, on the western half of the range, the ore structure changes, thin layers of sand alternating with thin layers of ore, so that most of the mines southwest of this point must use beneficiation plants to remove the silica. For the most part, the ore is covered with glacial drift which ranges in depth from nothing to 150 ft. and must be removed for open-pit mining and hauled to a dump some distance from the pit. At the largest mines these dumps cover over 200 acres of ground to a height of 50 ft. or more. Of the 80 mines that were operated on the range in 1937, 74 were open pits varying widely in size, depth, character of formation, and quality of ore.

When the first mines were opened with hand shovels, horses, and wagons in 1892, ore was secured close to surface with little overburden to be removed. A few years later a small steam shovel was tried out with success; then followed in succeeding years a procession of dinky steam locomotives, larger shovels, cars, and locomotives, until by 1927 10-cu.yd. electric shovels, 30-cu.yd. air-dump railroad cars, and 140-ton 0-8-0 steam locomotives were in use. Since then the size of new locomotives has not increased, but the new dump cars such as those used at the Missabe Mountain mine, at Virginia, are built for a live load of 75 tons with the car weight of only 57,200 lb., compared to 84,500 lb. for an old-style side-dump car carrying 75 tons. This reduction in weight was secured by using alloy-steel bars and plate of high tensile strength and a new truck design, as shown in the cars made by the Differential Car Company. Each car rests on its two trucks in spherical seats and there is no cross-axle between the wheels, which are roller bearing. These cars have been in service more than one season and have proved amply strong for the rough, heavy service required.

Such large shovels as those mentioned have since been found uneconomical, and today operations call for more 4-cu.yd. electric shovels than for shovels of other size. Although 5-cu.yd. machines are the largest required in the pits making the largest production, the trend is toward smaller, faster machines.

During this period of 45 years, over a billion tons of iron ore has been mined and shipped as well as millions of cubic yards of overburden removed, resulting in pits that vary in size from the Hull-Rust-Mahoning, the "man-made Grand Cañon of Minnesota," which covers more than a square mile, to small deep pits with an area of less than twenty acres. All of the older pits were laid out on a definite plan with a standard-gage railroad track system leading into the mine on a down grade varying from 1½ to 4 per cent, depending on length, width, and depth of deposit. As a mine became deeper, switchbacks were added, lengthening the haul and causing desirable tonnage to be tied up in track benches, until finally the point has been reached where it is felt that the deepest of them can reduce their haulage costs by adopting one of the more recently developed systems that are now being tried out.

The Hull-Rust-Mahoning pit is the best example on the range of an orebody large enough and not to deep for economical steam haulage. Here 120-ton locomotives haul twelve 30-cu.yd. cars in a train on a trackage that is as

carefully laid to grade as that of a trunk-line railroad system. The tracks for taking the empty trains back into the pit are held to grades of less than 5 per cent, and the loaded trains come out on a grade of 1½ per cent. When needed, this one pit can produce 15,000,000 tons of ore without apparent rush or overtime.

The Susquehanna mine, at Hibbing, reached a depth too great for steam locomotives several years ago and replaced them with an electrified system of haulage running from the pit benches to a shaft through a tunnel. Fig. 2 shows the pit with the 4-cu.yd. electric shovel, the 12-cu.yd. cars and the locomotive that hauls to the shaft through the tunnel "A." The ore is delivered to railroad cars on the surface at the shafthouse "B" by 4-ton skips hoisting in balance. This is the only electric haulage system on the Range that provides for a load on the locomotive. The 12-cu.yd. cars are small compared to those of 30 cu.yd. capacity that are being used in similar installations at limestone quarries in Michigan.

No electric haulage systems employing remote control are used on the Mesabi. On the Marquette range in Michigan, however, the "Woodford" remote-control system has given satisfaction at the Volunteer mine. Six or more 10-cu.yd. cars on the pit trackage are operated by one man from a tower on the bank. By placing a motor on each axle these cars can operate on grades up to 10 per cent. This might be the correct application for some Mesabi pits, but so far the operators have not adopted it. (The most recent installation of this system, completed this spring, is in a large limestone quarry in Alabama.)

Haulage of ore by trucks is one of the systems that is now being tried out on the Mesabi not only by operators who are getting out small tonnages from almost exhausted pits but by those who are mining over a half million tons per season. In size the trucks used vary from a 2-ton Ford to 15-ton

Fig. 2. . . . THE SUSQUEHANNA MINE, at Hibbing. Here electric trains (in which the locomotive also carries a load) take the ore mined in the pit through a tunnel, the portal of which is seen at A, to the shaft B, where it is hoisted to surface

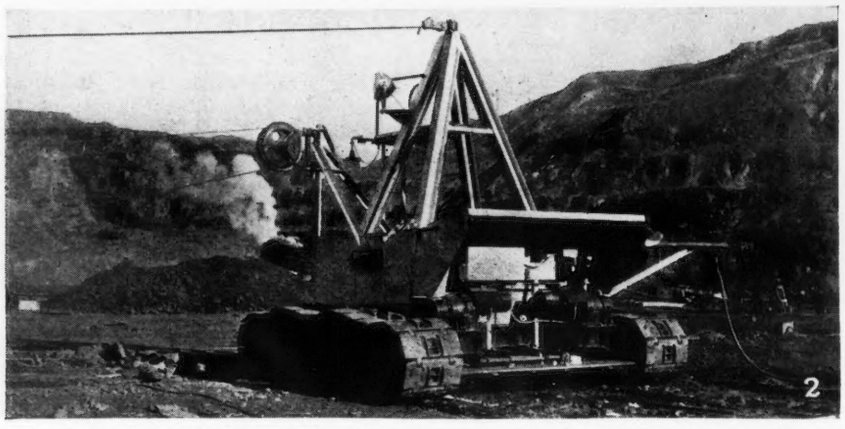
Euclid, Mack, Hug, Auto Car, and International makes, and to White 20-ton trucks. Most of these are giving a good account of themselves, and are still under test to determine their life and ruggedness under severe service. The makers estimate a life of 10,000 hours. The longest test on them so far is 4,500 hours, but they are still in good condition and may last longer than the guarantee. The larger trucks are equipped with diesel engines, come up the bank from the bottom on a maximum 10 per cent grade, and return to the bottom on another road of 14 per cent grade with the engine disconnected and the air brakes partially set. This practice saves the power unit and returns the truck quickly. To date, no accidents due to high speed have been reported. With four makes of trucks of 15-ton size on the same road circuit from the pit to the ramp on the surface, one operator is keeping a close check on haulage costs for the individual machines. This test has shown up some weak points on each machine. When it is over and the weak points are remedied, a truck for most severe haulage, under Mesabi range conditions, will doubtless be an actuality.

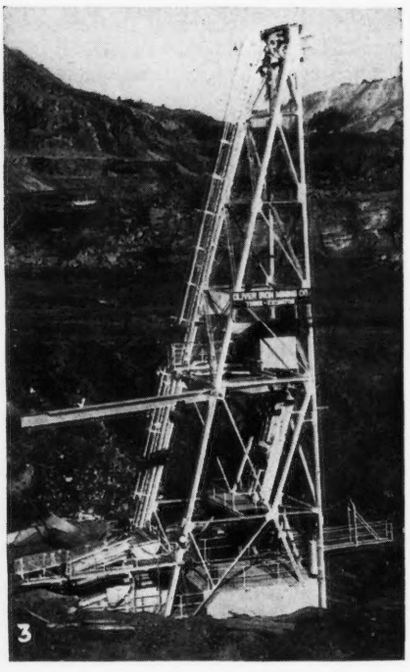
Similar tests are being run on large-size tractors and wagons. The RD8 Caterpillar tractor hauling a 15-ton Athey wagon is the largest in operation and is used up to a 1,200-ft. haul. There is keen competition between tractor and truck maker, and the claims of each are being tested by the operator, often at the expense of the maker, who seems to feel that future investments warrant the experiments.

Transport on belt conveyors for various distances and grades is receiving much consideration. Loading direct on the belt from the shovel has been tried at the LaRue mine, near Nashwauk. The shovel was working in a stockpile accumulated from underground operation during the winter. See *E.&M.J.*, March, 1936. At the Canisteo mine in 1937 a 36-in. belt conveyor was used to clean out a deep pocket of ore too expensive to reach by railroad tracks. A 4-cu-yd. shovel loaded into a portable pocket that was covered with grizzly bars to screen out the plus 12-in. material. A pan conveyor in the bottom of the pocket fed the ore to a belt conveyor which dumped directly into dump cars at a higher elevation.

When railroad electric haulage had proved its economy, two of the open-pit mines on the range, the Mesabi Chief and the Hill-Annex, were of such size and condition that the operators found it worth while to scrap their old steam equipment and electrify them. The Hill-Annex mine, at Calumet, has the largest installation. At this mine over 30,000,000 cu. yd. of stripping, consisting of both surface and lean wash material, has been removed and over 20,000,000 tons of ore shipped. The depth of stripping has reached 240 ft., and this, with

Fig. 3. . . . IN THE ST. PAUL PIT, near Keewatin on the Mesabi range. Here the ore is loaded by shovel into wagons and hauled by tractor to the nearby crusher and pocket (under the light-colored building) which delivers to the conveyor, which, in turn, runs from underground up and out of the pit



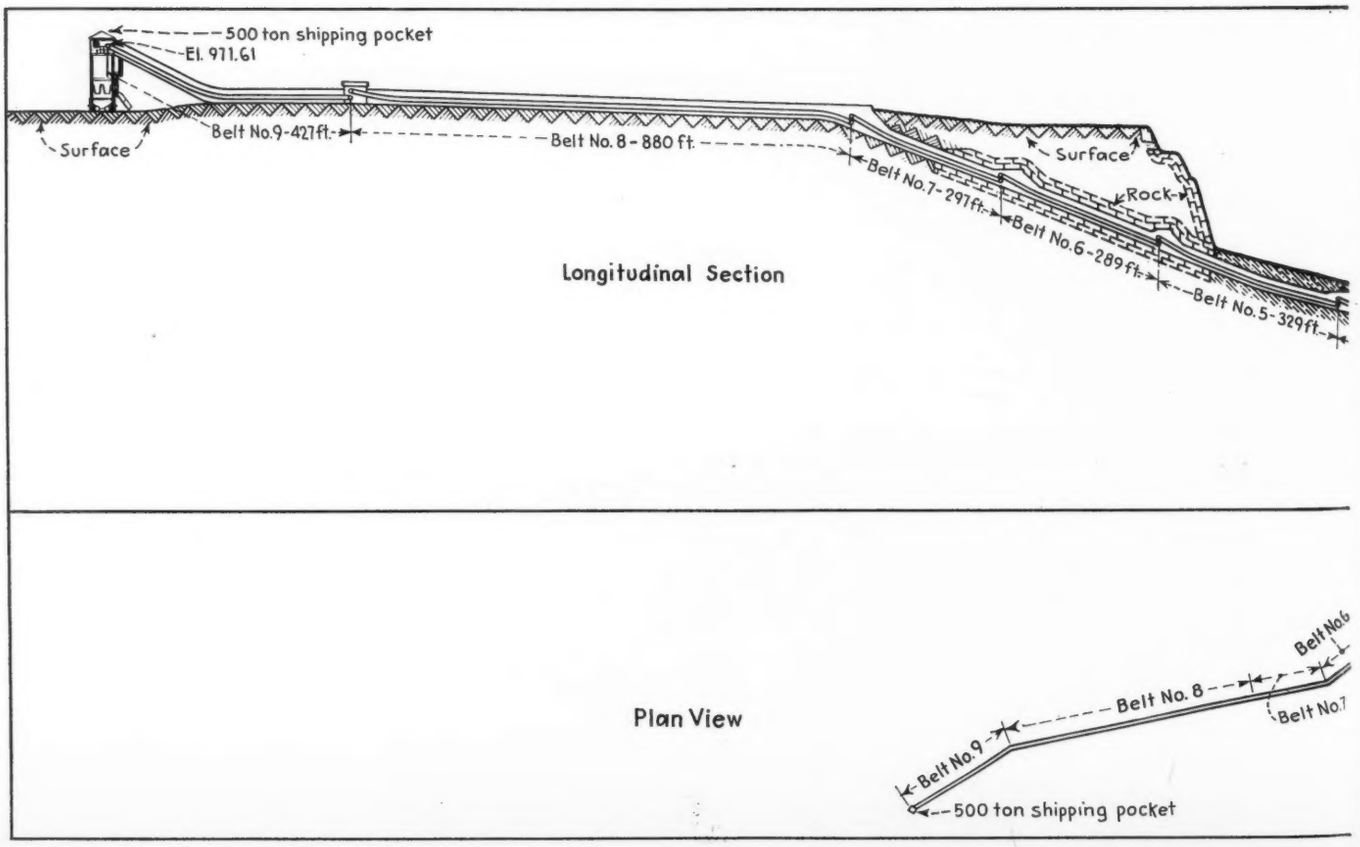


1. In the Spruce pit, Eveleth, Minn. Tower-excavator unit at No. 1 raise is seen, with anchor tower at extreme right. 2. Mobile anchor tower controlled from operator's cab in excavator-tower. 3. One of the two excavator-towers. It is set over a vertical raise in the orebody delivering to the conveyor system and combines excavating, screening and crushing equipment. See drawing

the fact that some ore needs beneficiation, requires a total electrified trackage in the pit and from the pit to the washing plant of close to 20 miles, all of it on a grade not exceeding 2 per cent. Some points in favor of this type of haulage are:

1. The steam locomotive requires a train crew comprising an engineer, a fireman, and a brakeman, whereas the

Fig. 5. . . . THE CONVEYOR SYSTEM that serves the Spruce pit at Eveleth



electric locomotive has a crew of only two, engineer and brakeman.

2. When not working, the steam machine needs a watchman and, moreover, close to 25 per cent of the fuel used in hauling to keep the steam pressure up. In contrast, the electric locomotive uses no current and is always ready for operation without a man to maintain the fire.

3. Average maintenance for electric locomotives is only 75 per cent of that for steam locomotives.

4. Six 75-ton loaded cars can be hauled up a 2 per cent grade with a 75-ton electric locomotive. A steam machine of the same weight can pull only five similar cars.

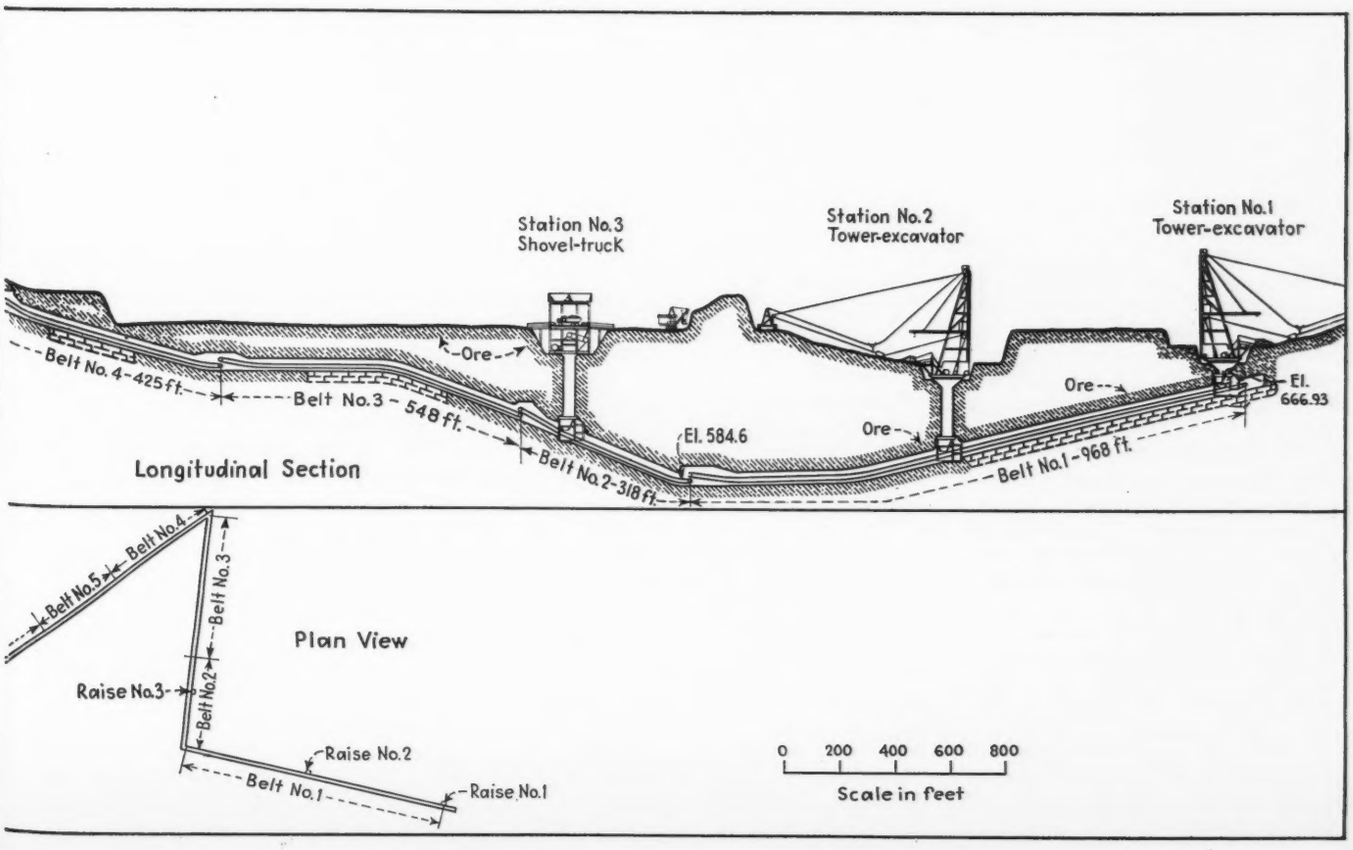
5. The maximum speed of a 75-ton steam locomotive hauling five 75-ton loaded cars up a 2 per cent grade is 8 m.p.h., whereas an electric locomotive of the same weight and load can haul six similar cars up the same grade at 10 m.p.h., or, in other words, an electric locomotive can haul 1.8 times as much ore as a steam locomotive in a given time.

6. At present, the price on 75-ton steam locomotives is $40,000, compared to $25,000 fifteen years ago, whereas the price on electric locomotives has dropped from $45,000, in 1925, to $32,500, the present quotation.

In 1936 a new type of haulage was installed at the St. Paul mine, near Keewatin, illustrated on page 45. This open pit had shipped over 3,000,000

(*Continued on page* 55)

4. An electric shovel in the Spruce pit, at Eveleth, loading a 20-ton truck serving the screening and crushing plant over No. 3 raise. 5. The 20-ton load of iron ore being dumped at No. 3 raise



Treating
Precious Metal Speiss

Some details of current practice in Great Britain for large-scale separation of metals of platinum group

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COLLECTION of precious metals of the platinum group by means of arsenic has been in use for more than half a century, and was originally introduced by D'Hennin for the treatment of goldsmith's sweepings. Although Muspratt and other early chemists commented on this process at some length, it did not receive much publicity, in view of the paucity of precious-metal smelters throughout the world. The high market price of these metals has tended to create the erroneous impression that their extraction and recovery is complicated, necessitating involved experience of chemistry and metallurgy. The only complicated part of the whole work arises from the need for complete reclamation, because of the large monetary value at stake. If other metals had to be extracted with such absolute precision, equally complex problems would probably arise.

To obtain a fair idea of the nature of the work, comparisons should be made between the final stages of separating the elements of the platinum group, and those of the rare-earth group. It will then be realized that the latter work is much more complicated, and that the constituents cannot be simply collected in a speiss, as done with the former. When treating the original platinum concentrates and residues, they are melted on to arsenical lead, and the drosses formed skimmed off. The lead remaining contains most of the platinum and palladium, but the drosses collect the other members of the group almost completely. Iridium, rhodium, and ruthenium are present in this dross, or "white metal," almost to their entirety, if the process is properly operated, whereas osmium, despite its volatile nature and tendency to sink into the furnace bottom, is obtained mostly in this residue. By means of repeated sulphurizing, the "white metal" is concentrated to speiss, and in this treatment, the nickel arsenide acts as a nucleus, retaining the precious constituents unharmed. So long as other base metals, such as copper, iron, lead, and antimony, persist in this speiss, it is subjected to a further sulphurizing with salt cake (sodium sulphate) and coal.

This application of the ordinary "top-and-bottom" process for concentrating "white metal" to speiss has enjoyed innumerable ramifications, but probably none quite so uneconomical as the foregoing. Instead of curtailing, or completely eliminating, this process, several precious-metal smelters still continue to use it, as the profits from the high-priced constituents justify it, and hence science is placed at a discount.

Bought speisses containing precious metals, and still retaining some of the base metals, are usually subjected to this sulphurizing treatment, and the most prominent of these is the Rand speiss (Moir's speiss), which represents one of the richest residues, but as the South Africans do not undertake to work it, it has been on sale periodically for many years.

Initial Treatment of the Concentrated Speiss.—The final stage of the speiss-sulphurizing consists of tapping the speiss from below the alkaline matte to an iron buggy, where it is allowed to cool, prior to reducing it to fine powder with the aid of breaker and grinding mill. The speiss is not a true speiss, and frequently contains considerable sulphur. If properly worked, it should be free from base metals other than nickel and arsenic, but as a rule contains some 8 per cent of impurities, divided among copper, antimony, lead, and iron. The precious constituents are tabulated in ounces per ton, but in percentage average about 4 per cent.

Thus the work of forming a "white metal," and converting to a speiss, only concentrates the precious metals to this latter small figure, and many weeks have elapsed in carrying it out.

The question might aptly be asked why such dilatoriness should be indulged in, inasmuch as in the interval, the market prices might change very materially. However, the high monetary value involved and the secrecy observed have done much to retard improvements.

The removal of the 96 per cent of the base-metal constituents is done by what might be termed large-scale laboratory methods. For some years, the sulphur and part of the arsenic were roasted off on a small hand-operated, coal-fired oven. This was constructed with a lengthy flat bed of firebrick, and a small fire grate, and a number of doors were built along one side, to facilitate handling of the mass, at different stages.

The finely pulverized speiss was placed in a thin layer at the cool end of the hearth, and roasted so far, after which it was brought forward towards the grate end in stages, until at the final stage it was practically sulphur-free, and had a reduced arsenic content.

As the roasting tended to agglomerate the mass slightly, it was screened periodically, and the "roughs" were ground, and returned for further roasting. The established method of roasting speiss with coal dross so as to expose a fresh metallic surface of the arsenic intermittently was not adopted in the approved manner, possibly because of the fear that coal ash would be added to the roasted mass.

At a later date the direct roasting was abandoned without applying alternative methods of eliminating the sulphur and arsenic, and in its place, direct treatment with nitric acid was substituted. A still was constructed of Staybrite heated by gas and equipped with an automatic stirrer. Other so-called corrosion-resisting stills were also used. The speiss was introduced in small lots at a time, and dissolved in the nitric acid.

The oxides of nitrogen evolved were allowed to escape without treatment, but the surplus nitric acid was partly recovered in a worm condenser. The

solution so formed was evaporated to dryness, and then removed from the still. This mass was placed in crucibles and raised to a dull red heat. As the speiss sometimes showed a disposition to be slowly attacked by nitric acid when in insufficient quantity, a surplus of acid was purposely added, and had a good acid recovery process been adopted, the expenses would have been materially reduced. In the ordinary way, 16 lb. of speiss were treated with 10 gal. of 1.25 sp.gr. nitric acid (still capacity, 44 gal.).

The crucibles were not placed in pit fires, but simply laid on the hearth of the roasting oven, where the dull heat reacted.

Dissolving Out the Platinum—This roasted mass is treated with hydrochloric acid in a steam-heated pan equipped with a stirrer, with an earthenware vessel within. Should the latter break, provision is made for recovery of the contents. Hydrochloric acid does not attack the roasted speiss with vigor, and the process is slow and tedious. One hundred and fifty pounds of speiss require 120 gal. of acid, and the heating and stirring have to be maintained until ultimately most of the mass passes into solution. In some cases, it is necessary to repeat the treatment with acid, depending on the extent of its insolubility.

The acid gases which escape are made to pass up an earthenware flue to recover drips of acid expelled, and the arsenic chloride formed passes to a receiver. Although I have mentioned the approximate proportions of speiss to acid, it should be understood that the fine mass is added from a spoon, in a thin stream, in very small lots at a time, as this gives the acid the opportunity to react most easily.

In some cases only 18 gal. of the extracted nickel liquor was obtained daily, which indicates the slow nature of the process. In one instance 3½ cwt. of speiss was dissolved in 200 gal. of hydrochloric acid in two weeks. The dissolving pans have a capacity of 15 gal., but larger makes were contemplated.

The accumulation of speiss from a year's treatment of goldsmith's sweepings, and precious-metal residues, approximates 14 cwt.—that is, not including consignments from the Rand mines.

The result of the treatment is that the platinum present in the speiss is largely dissolved out together with the nickel, and the green liquors so obtained are transferred to an earthenware piggin. It is necessary to continue the heating and stirring with hydrochloric acid so long as nickel remains in the insoluble residue. Chlorine is then passed into the nickel liquors from a cylinder and glass tube, and the platinum precipitated by adding ammonium chloride by the approved laboratory method.

The concentrated speiss averages about 500 oz. of platinum per ton, so that, as most of the platinum is dissolved from the 3½ cwt. treated, it is obtained in this precipitate.

If sufficiently pure, as a result of careful treatment, this precipitate may be reduced directly to platinum sponge, followed by conversion to metallic platinum. As a general rule, however, the nickel liquors are simply run through a vacuum filter, and the precipitate is washed and transferred to the laboratory for drying, weighing, and analysis, and, if the purity justifies it, the direct reduction to platinum sponge is carried out. Otherwise it has to be treated further.

So far as the more precious constituents are concerned, practically none of them are dissolved by the hydrochloric acid treatment, but when the work is done carelessly, a few ounces per ton of iridium may make its appearance. Inasmuch as the original lead, on which the residues were melted, collected most of the palladium, only about 4 oz. per ton is present in the concentrated speiss, and this can also be dissolved by the hydrochloric acid.

Hence the platinum precipitate, or "ammonium chloroplatinate," has frequently to be subjected to a short refining prior to conversion to sponge, as described in books on chemical analysis.

The conversion to sponge is done in a tarred crucible, and heat applied gently to prevent minute particles of platinum being carried away by the gases. The dark-gray precipitate so obtained is reduced to metallic platinum on a cut block of limestone, with the aid of the oxyhydrogen blowpipe. Electric furnaces of the induction type have also been used for this purpose, but the initial outlay was not considered worth while and the early blowpipe was persevered with.

It was pointed out that despite the fear that carbon would be absorbed, other electric furnaces could be converted to suit platinum melting. Enterprise in this direction, however, has not manifested itself, and the arc-resistance furnace has not been given the opportunity of a trial, but inasmuch as the total platinum per annum

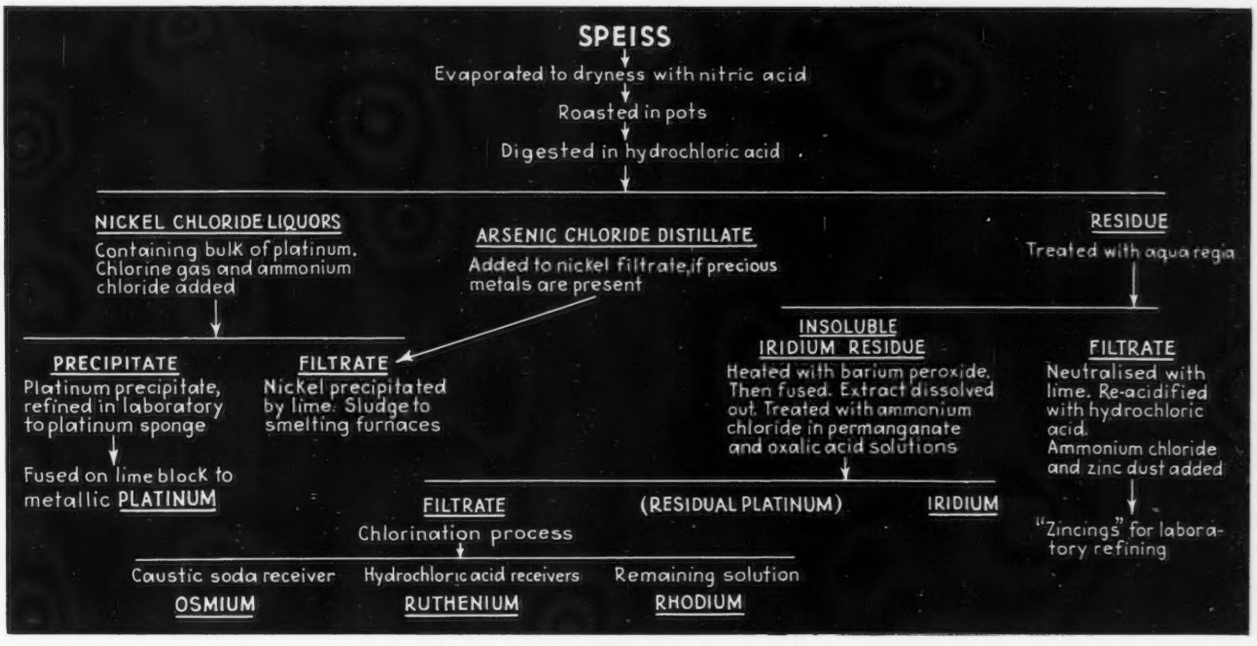

SPEISS
Evaporated to dryness with nitric acid
Roasted in pots
Digested in hydrochloric acid
NICKEL CHLORIDE LIQUORS
Containing bulk of platinum. Chlorine gas and ammonium chloride added
ARSENIC CHLORIDE DISTILLATE
Added to nickel filtrate, if precious metals are present
RESIDUE
Treated with aqua regia
PRECIPITATE
Platinum precipitate, refined in laboratory to platinum sponge
Fused on lime block to metallic PLATINUM
FILTRATE
Nickel precipitated by lime. Sludge to smelting furnaces
INSOLUBLE IRIDIUM RESIDUE
Heated with barium peroxide. Then fused. Extract dissolved out. Treated with ammonium chloride in permanganate and oxalic acid solutions
FILTRATE
Neutralised with lime. Re-acidified with hydrochloric acid.
Ammonium chloride and zinc dust added
"Zincings" for laboratory refining
FILTRATE
(RESIDUAL PLATINUM)
IRIDIUM
Chlorination process
Caustic soda receiver
OSMIUM
Hydrochloric acid receivers
RUTHENIUM
Remaining solution
RHODIUM

Fig. 1. . . . FLOWSHEET illustrating the procedure used in treating precious-metal speiss in some British plants

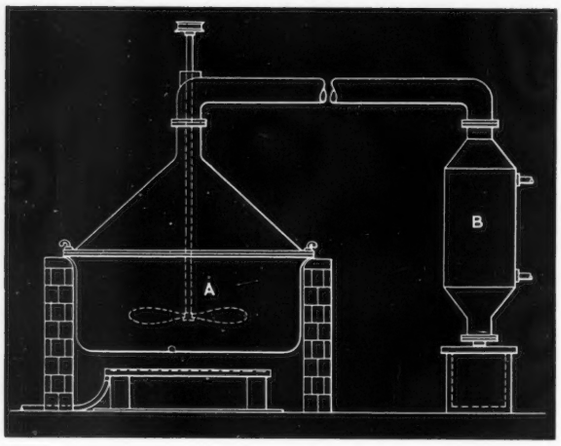


Fig. 2. . . . STILL for initial nitric-acid treatment of speiss. The stirrer, *A*, is necessary only when bumping occurs. The condenser, *B*, collects surplus nitric acid evolved

is not considerable, in bulk, the blowpipe is still used.

Handling the Nickel Waste Liquors.—The nickel liquors filtered from the platinum precipitate are transferred to a series of casks, or if the bulk justifies it, to a wooden tank, and precipitated by addition of lime in excess. The weight of this precipitate usually approximates to eight to nine times that of the original speiss, and the reason for this excessive bulk lies in the difficulty of precipitating nickel completely by lime. Milk of lime was used for some time, but later lime alone was shoveled in until a slimy mass was obtained, which was allowed to dry by exposure to the air.

The analysis of this sludge varied considerably accordingly, but on the average it contained from nothing to 4 oz. of gold, 50 oz. of silver, 7 oz. of platinum, 9 oz. of iridium, 3 oz. of palladium, and 3 oz. of ruthenium per ton.

For some time, small proportions of this sludge were added to the smelting furnace charges so as to insure nickel being present to form an appropriate speiss with the arsenic present in the lead, and make the usual nucleus for collecting the platinum metals. As the goldsmith's sweepings, residues, and concentrates periodically contained nickel, this metal was thus increasing in bulk on the premises, and the addition of nickel sludge became unnecessary.

It was further realized that the much-advertised complexity of extracting the platinum metals by smelting was hopelessly overrated, and that even an iron speiss containing a small proportion of nickel was sufficient to insure a thorough collection of the precious constituents.

The sludge was later smelted with fluxes so as to recover the precious constituents in a crude speiss, and the following charge was found to melt at a comparatively easy reverberatory temperature: 16 cwt. nickel sludge, $1\frac{1}{4}$ cwt. purple iron ore, $1\frac{1}{4}$ cwt. sand, $\frac{1}{4}$ cwt. coal dross, and $1\frac{1}{4}$ cwt. blast-furnace slags. The products were a large bulky slag and a small variable proportion of crude speiss.

This principle of handling the nickel left much to be desired, and many established metallurgical ideals were eschewed in the process, but which sufficed to make profits, because apparently so few firms were engaged on this work and thus able to compete on scientific lines. In this connection certain nickel firms have been guilty of placing metallic nickel on the market which contained minute proportions of the platinum metals for the same reason.

Digesting the Residue in Aqua Regia—The insoluble residue left after the treatment in hydrochloric acid is transferred to a second earthenware vessel contained in a steam-heated pan, equipped with a stirrer of the same make as the previous plant. Instead of hydrochloric acid, aqua regia is now used, and the fine mass continually stirred, and heated until no more metal will pass into solution. The liquor so obtained is filtered through a vacuum filter, made alkaline with lime, and re-acidified with hydrochloric acid. Ammonium chloride is then added, followed by zinc dust, which insures complete precipitation of the platinum, any little palladium present, and what iridium happens to be dissolved out by the treatment. This precipitate is washed, dried, and weighed, and goes under the category of "zincings." It contains 27 oz. of gold, 145 oz. of platinum, 72 oz. of iridium, occasionally up to 23 oz. of palladium, 47 oz. of rhodium, and 32 oz. of ruthenium per ton.

These figures vary from time to time, and of more recent years the rhodium content has fallen perceptibly. The condition of alloying, and ratios of one constituent to the other, exert a marked influence on the extent of solubility in aqua regia, in the same manner as with other insoluble metals. Thus the insoluble residue from the aqua regia treatment contains the same metals but in different proportions, and goes under the category of "iridium residues."

It is washed, dried, and weighed, and the analysis shows 14 oz. of gold, 107 oz. of platinum, 373 oz. of iridium, 29 oz. of rhodium, 128 oz. of ruthenium, and from nil up to 4 oz. of palladium per ton.

To summarize, the first treatment with hydrochloric acid dissolves out most of the platinum, and the second treatment with aqua regia dissolves out half of what platinum remains, leaving an iridium residue. As mentioned, the precious-metal content in the original concentrated speiss approximates to 4 per cent, and this is now divided among the platinum precipitate, the "zincings," and the insoluble "iridium residues."

If the ratios of the respective precious metals happened to be favorable, it might be possible to dissolve out the platinum from the iridium, thus giving a more rapid recovery of platinum, but in practice the separation is far from complete, and some of the iridium is invariably dissolved.

The iridium residues and "zincings" are removed to the laboratory, for separation of the constituents.

Another material which accumulates from another process is what is known as "crude iridium," and which is subjected to the same ultimate laboratory treatment as the two foregoing.

(To make this clear, practically the whole of the iridium, ruthenium, rhodium, and available osmium was collected in a nucleus of nickel arsenide during the original smelting on to lead. The bast bulk of the platinum and palladium remained in the lead which was transferred to the "test," or cupellation, hearth and was ultimately recovered. During this recovery process a small insoluble residue is obtained—namely, "crude iridium.")

The analysis of this approximates to 754 oz. of iridium, 106 oz. of ruthenium, 27 oz. of rhodium, 7 oz. of gold, and 14 oz. of platinum per ton.

Although the proportions are different from those in the foregoing "zincings" and iridium residues, it will be seen that this latter small product makes a third material of similar constituent composition. At first, a wide variety of methods culled from different analytical books and papers was used for treating these rich materials, but latterly, the three of them were subjected to more or less the same process.

It might be contended that in view of the fact that similar products are obtained at different sections of the process, considerable elimination of the intervening treatments might be instituted, with a view to speeding up the recovery, and avoiding trouble with the changing of market prices. The process described, however, is persevered with to the present day, and is carried through as a regular routine.

Present-Day Fusion With Barium

Peroxide.—The different iridium products are subjected to fusion with barium peroxide following the original method worked out by Deville and Debray some 70 years ago. In the intervening years, the process has seen but little improvement, although different mixtures consisting of barium peroxide and nitrate, barium peroxide and sodium carbonate, etc., have been substituted.

In the laboratory, sodium peroxide is used for the fusion. The separation of the constituents on the large scale is carried out, much as in the laboratory.

Nickel crucibles are preferred in the laboratory, but silver crucibles are sometimes preferred in working on the large scale. They are heated in a gas-fired muffle furnace. The iridium residues are intimately mixed with the barium peroxide fusion mixture, introduced to the crucible, and heated at a dull red heat for some time before fusing, which point is important to insure complete solution later.

After fusion is complete, the mass is poured, ground to a fine condition, and digested in hot water, or acidulated water. It should pass practically completely into solution if properly treated, and it is then given an excess of sulphuric acid to precipitate the barium as sulphate. The barium sulphate is filtered, washed, and returned to the smelting furnaces, where it becomes incorporated mainly in the slag, the barium reacting in much the same manner as lime, and the sulphur passing largely into the matte. The reason for returning this precipitate is that it contains some precious contents: 78 oz. of silver, 17 oz. of gold, 7 oz. of platinum, 31 oz. of iridium, 14 oz. of rhodium, and 14 oz. of ruthenium per ton. Although the silver crucible withstands the effects of the heat, the high silver content present in the barium sulphate accounts for partial corrosion.

When the silver crucibles are too well worn for further use, they are melted on the "test" for recovery of the metal.

In the laboratory assay, the liquor from the fusion is directly subjected to the usual chlorination process, whereby ruthenium and any osmium present are evolved, being collected respectively in acid, and alkaline receiving solutions, from which the metals are recovered by precipitation with ammonium sulphide in both cases.

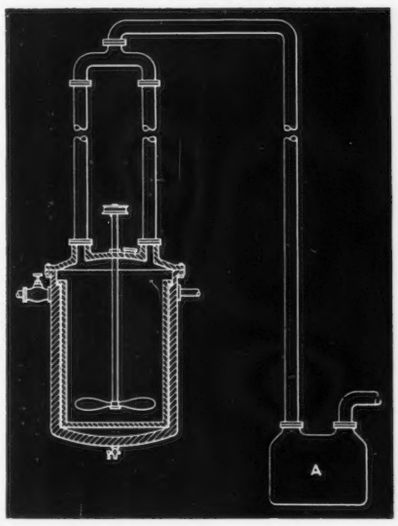
Though this satisfies for laboratory estimations, the process on the large scale is altered in view of the large percentages of iridium and platinum which are present, and which it is desired to recover, before proceeding to the minor quantities of ruthenium, and osmium. The chlorination process for ruthenium and osmium, either in the laboratory, or on the large scale, does not appear to have been altered from that described in textbooks on analysis —that is, using a chlorine cylinder and a train of Wolff bottles—and the ultimately precipitated metals are reduced under hydrogen to the metallic state when they are packed in small bottles for sale.

Coal-gas reduction has also been successfully applied.

On the large scale, the liquor from the barium peroxide fusion is first treated for separation of iridium and platinum, and a glance at the figures enumerated will reveal the necessity for dealing with them first. The early method of reducing the solution with sodium hypochlorite and precipitating iridium with sodium sulphide has more or less been abandoned in favor of different ammonium chloride treatments, but although the precipitate so formed was dirty, and difficult to handle, it represented one of the most complete methods of separating iridium from platinum.

Ammonium chloride precipitates platinum as the chloroplatinate, which has to be filtered after a short interval of settling, after which the iridium comes down as chloriridate, but this has been improved on by oxidation and reduction, using oxalic acid and ammonium chloride, and potassium permanganate and ammonium chloride, for separating the respective metals. After boiling and filtering, from these respective additions, the iridium and platinum precipitates are heated in fused silica crucibles to sponge, or "moss," after which they are reduced to metallic condition under hydrogen or coal gas. The use of permanganate and oxalic acid gives both a complete separation of iridium and platinum, and precipitates which are easily handled. It is then that the chlorination process for evolving ruthenium and osmium is applied.

Fig. 3. . . . DISSOLVING PAN, steam-heated, for digesting oxidized speiss in hydrochloric acid and then treating with aqua regia. *A* is a receiver for collecting evolved arsenic chloride



As a rule, the platinum sponge contains some 990 per 1,000 of platinum, and impurities in the form of silver, gold, and iridium may be present in minute proportions. Until the introduction of the silica crucibles, all sponges had to be well washed in dilute hydrochloric acid to remove a trace of iron picked up from the sides of the clay pots, which were earlier used. This work is carried out in a small laboratory set aside for the purpose, and the different precious metals finally reduced to metallic condition are comparatively pure, with the exception of iridium. One sample sent to market contained (in parts per 1,000) 987 of iridium, 2.8 of rhodium, 2.7 of platinum, and 1.7 of ruthenium, the remainder being made up of base metals.

A sample of metallic ruthenium contained as much as 6.7 per 1,000 of iridium.

These impurities do not appear to be of sufficient account to interfere with the sale of the products, but do not compare favorably with electrolytically deposited gold or silver.

Precautionary Measures Adopted—As with most work connected with the precious metals, various provisions are taken to insure safety from loss of the valuable contents. In the plant originally detailed for digesting the concentrated speiss in hydrochloric acid, should the earthenware vessel crack, the green nickel liquors will then pass into the condensed water of the steam-heated pan, and the attendant periodically examines this to note if there is any evidence of color.

In the "zincing" process, should the zinc dissolve too rapidly in the hydrochloric acid, some precious metal may remain not precipitated, and a sample of the solution is tested in the laboratory, and if necessary a second treatment with fresh acid and zinc dust is made. During the boiling with hydrochloric acid, the arsenic is evolved largely as chloride, and condenses in a small receiver used for this purpose. To insure that no precious constituents should be carried off, it is customary to add this condensate to the nickel liquors for liming-down.

All old pots and vessels which have reached the disused stage are broken up and added to the slag heap, which has to be smelted in a small blast-furnace.

Similarly, all filtrates, or waste liquors obtained throughout the treatment are thrown over any fresh goldsmith's sweepings which have to be smelted. It should be mentioned that these finely ground masses are always liable to losses through dusting and require to be wetted in any case.

The Rand speiss, or Moir's speiss, generally differs from other speisses in

that it contains some 80 oz. per ton of osmium, whereas many of the others are practically free from it. For this reason it is customary to subject all Moir's speiss to an initial treatment with nitric acid prior to smelting, as, in this way, volatilization losses are obviated.

In conclusion, the secretive policy adopted by some of the precious-metal firms is much to be deprecated, as they have very apparently lost much, and gained little. Whereas in other metallurgical processes, free intercourse, discussion, and cooperation are essential to progressive development, the platinum group of metals appears to be hidden under a bushel because of the excessive privacy maintained.

Although expensive, because of their rarity, the platinum metals are among the simplest metals to concentrate, extract, and refine, when compared with many of the other rare elements, and it is perhaps unfortunate that the multiplicity of figures has conveyed the false impression of great complexity.

Despite the fact that the cost of purchased precious-metal speiss amounts to tens of thousands of pounds sterling annually, the total cost of the plant necessary to separate completely the platinum metals does not exceed more than a few hundred pounds.

Electrostatic Separation—II

(*Continued from page* 43)

After eighteen years of continuous association with the art, I felt that the field of electrostatic separation was limited to the treatment of a few of the more valuable materials and restricted entirely to the separation of conductors (metallic minerals) from non-conductors (non-metallic minerals) as shown in textbooks dealing with ore dressing.

From 1918 to 1926 I designed and operated, as general manager, a flotation-electrostatic plant in Burnet and Houston, Texas, producing the highest quality American crystalline flake-graphite ever offered to manufacturers of dry batteries.

In 1927 and 1928 I designed probably one of the first colloidal-flotation plants for recovering precipitated carbon from calcium carbonate sludge—all the flotation feed passing approximately a 325-mesh screen.

Previously I had learned of the drawbacks and objectionable features of dry separation—the dust losses and general working hazards in a dry plant before the days of air conditioning and dust-collecting control.

My experience in flotation work did not, as I had expected, discourage me further as to electrostatic separation. I found I was simply exchanging one group of drawbacks and difficulties for another group of imperfections and difficulties.

Improvements in dust-collecting methods have eliminated to a large extent the two most objectionable features of dry concentrating plants—dust losses and the dust nuisance. Remarkable improvements have been made in drying operations and cost.

No account of the historical development of electrostatic separation, even in a mining journal, would be complete without making mention of the application of the process to the food industries.

In 1931, a well-known coffee processing company was unable to remove enough chaff from its coffee by available air-gravity methods. I designed and installed electrostatic separating equipment which has been operating satisfactorily ever since.

In 1932, a mustard manufacturer in New York City had about 250,000 lb. of mustard seed shipped to him which was condemned by the Department of Agriculture as filthy. I installed electrostatic equipment which removed all the impurities and produced a practically pure product that easily passed inspection. Since this installation was made, every pound of mustard seed in this plant has been cleaned electrostatically, producing in this manner the purest mustard.

Several other electrostatic installations were made in the food industries, presenting many new problems, and renewed my interest in the art.

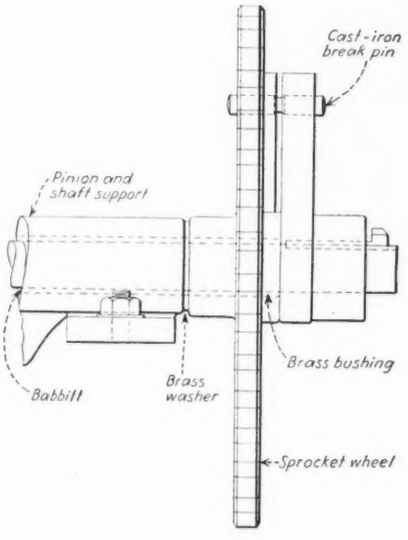
Recently new and important discoveries have broadened greatly the field of application of electrostatic separation, especially for the separation of non-metallic minerals and food products. These new discoveries have already necessitated the rewriting of a mineral conductivity list and the developing of the new art of selective electrostatic separation.

The near future will, I believe, see the increasing use of a combination of processes in ore dressing, inasmuch as there are limitations to each basic principle of concentration—gravity, magnetic permeability, electrical conductivity, surface tension and more selective flotation operations. It is my opinion that many operators are beginning to realize that when some of the basic processes are refined to the extent of some present-day super-flotation operations, the results are more expensive than anticipated. Consideration, therefore, is already being given to using a combination of basic principles, fitting each one to the task for which it is best suited, thus using more simplified units and reducing the cost of operations.

A Simple Overload Device

AT A CYANIDE PLANT in central Mexico trouble was occasionally had with the home-made, bowl-type classifiers operating in the fine-grinding department. The rake mechanism in the bowl consisted of a vertical steel shaft with rakes slanting downward which was connected to the horizontal drive shaft by two bevel gears. Motive power was furnished by a simple chain drive. During a sudden or brief shutdown the sands normally returned by the drags to the tube mill would settle rapidly in the bowl and choke the rakes in a short time. When starting up again, bent rakes or a twisted shaft would often result, especially when the classifier was attended by a native workman.

To overcome this difficulty the chain drive was provided with a simple friction clutch, which proved unsatisfactory because the clutch would slip out of the drum at the slightest increase in pressure and thus render inoperative the rake mechanism in the bowl. The problem was finally solved by altering the drive in the manner as shown in the accompanying sketch. This involved boring out the sprocket wheel shaft bore and providing it with a brass bushing, and adding a lever-like end piece, which is keyed to the drive shaft. The loose sprocket wheel and the keyed end piece are held together by a grooved cast-iron pin. This pin breaks whenever the rakes become overloaded or choked and immediately stops the rake mechanism. After the bowl has been cleaned, a new pin is inserted and the classifier is ready to operate again.



Desert Silver

Cyaniding 175 Tons Daily

Mining is limited to the better-grade material. Mill capacity can be doubled readily if necessary

Fred E. Gray
General Manager, Desert Silver, Inc.
Silver Peak, Nev.

THE DESERT SILVER MINE is situated 9 miles southwest of Silver Peak, Nevada, and 29 miles from Blair Junction, the nearest railroad point. It was first operated many years ago under the name of Stimler mine. During this period the work was done in the upper horizon above the sediments. No commercial ore was encountered, there being only sufficient small pockets to offer encouragement for further work. Subsequent operations were financed by W. H. Colvin, with Fred Vollmar, Sr., in charge. The property was then known as the Nivloc mine. Some work was done in the upper horizon, but most of the money was spent in sinking the main shaft and prospecting the vein below the horizon of the volcanics. Save for some low-grade ore, nothing of particular interest was developed.

A few years later the property was acquired by Fred Vollmar, Jr., and was operated under the name of Red Mountain Mining Company. The venture was financed by Mr. Vollmar and by a RFC loan. During this period considerable commercial ore was encountered, and development of the mine was carried forward to a point sufficiently promising that a syndicate composed of Ira B. Joralemon and associates took an option on it. The option was obtained in January, 1937, and exploration operations under the supervision of P. G. Dobson were started at once. This work proceeded rapidly, and by the end of April sufficient ore had been developed to warrant the construction of a mill. Though there was the uncertainty as to the price of domestic silver (the undertaking was not attractive at the world price of silver), the syndicate members mentioned previously, together with a few other men, decided to undertake the venture, trusting that the domestic silver price would stay up long enough to allow their money to be returned, and hoping that in the meantime high-grade ore would be developed on the lower levels in a possible zone of secondary enrichment. Indications are excellent for such a zone.

A new company, named Desert Silver, Inc., was formed which took the property over from the syndicate.

THE DESERT SILVER mine and mill is 9 miles from Silver Peak, Nevada. The property was formerly known as the Nivloc and before that the Stimler

Ira B. Joralemon was elected president, with Fred E. Gray secretary and treasurer. Money to finance the enterprise was obtained by private subscription, and work started. At the end of April, I was engaged to take charge of operations at the mine. On May 1, when I arrived at the property, the entire mining equipment consisted of a small wooden headframe, a gasoline hoist, a diesel-driven compressor, a rented portable compressor, a blacksmith shop, a small house used for a boarding house, two huts, and a tent or two. Underground, there were available a few air drills and mine cars, and other miscellaneous equipment required for preliminary prospecting work. It was necessary to develop a water system, provide sufficient camp facilities to house and feed the men, provide adequate power, design and build a mill, equip and develop the mine for production, and to improve 9 miles of road to permit trucks to haul in the required machinery and supplies. Preliminary test work on the ore done by several people was checked in the Bralorne mine laboratory, in British Columbia, under my direction.

The early part of May was spent in making up a general plan of the plant and laying out a program of work for the development of the mine and an adequate water supply. Next, work was started on the design of a cyanide mill and crushing plant, which it had been decided was to have a capacity of 175 tons per day. The design of the mill was worked out by me, and as soon as the general layout was completed and equipment specified, bids were solicited. On June 8, a contract was signed with the Southwestern Engineering Company, of Los Angeles, Calif., for construction of the crushing plant, mill, 66,000-gal. water-storage tank, steel headframe, boarding house, bunkhouse, office and warehouse, and one dwelling. Time had not been sufficient for detailed drawings and complete specifications for the mill and crushing plant, so that arrangements were made with Southwestern Engineering Company to work out many of the details and make up the finished drawings. The drawings thus made up were to be approved by the mine manager. Such a contract could have caused considerable trouble to one or both parties thereto, and it is gratifying to state that neither party had any difficulty whatever with the other, the most cordial relations existing throughout the entire program.

The first load of lumber and construction equipment arrived at the property on June 16. On Oct. 1 the mill was started under the supervision of C. E. Tonry, and has operated steadily since. The only "tuning-up" delay experienced in the mill was due to hot pinion-shaft bearings on the ball-mill drive. Material milled in October averaged 180 tons per day, or 5 tons more than the rated capacity,

and recovery was very close to that indicated in test work, though after a few months' operation some metallurgical difficulty developed with ore from some newly found orebodies. As the tonnage in these is relatively small, no serious trouble is expected. Since the first month of operation the mill has handled about 200 tons per day.

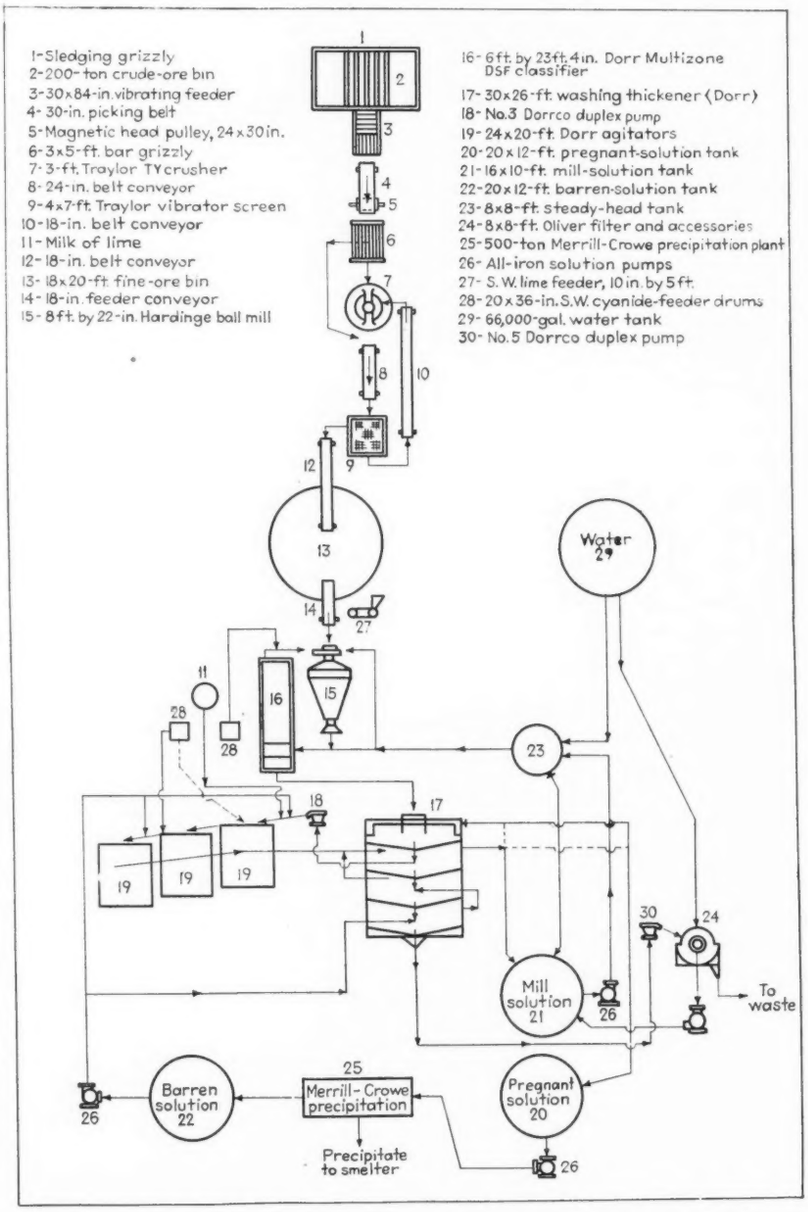
At the time the new company was formed some prospecting had been done as deep as 800 ft. below the surface. Little lateral work had been done, however, except on two levels, the 440 and 500. On these levels orebodies were indicated having a lateral extent on each of about 850 ft. No preparations for stoping operations had been made. The main shaft extended 440 ft. vertically below the surface, the bottom levels having been worked through a series of inclined winzes. It contained a hoisting compartment and a manway, and was timbered and in fair condition. Another inclined shaft, extending 100 ft. on the dip of the vein, existed. It was necessary during the surface construction period to erect a new headframe, install a new hoist, repair the shaft and provide new guides, cut a station on the 440 level, and carry out some preparatory work on the orebodies for mining, while at the same time making arrangements to hoist ore from the levels below the 440. During this period a new steel headframe was erected, an electric hoist installed, the shaft repaired, station cut, and silling operations were started on the 440 level. Other underground work done at that time included driving a 450-ft. incline raise for a second mine exit, driving a 500-ft. crosscut on the 600 level to a point under the shaft and cutting a station, and some drifting on the 600 level. The shaft was raised from the 600 level to the 440 level after milling had begun.

The ore, the principal value of which is in silver with appreciable amounts of gold, occurs as a quartz vein in sediments and cutting through overlying volcanics at the surface. Average width of the vein so far developed is about 60 ft. Its dip is 55 deg. The average of values over this entire width is rather low. In the vein, however, there are lenses of ore of higher values varying in width from 2 ft. to 20 ft., an average being 6 or 7 ft. This condition left two courses open: (1) To mine and mill a large quantity of low-grade material with a consequent large outlay of capital, and (2) to mine and treat a smaller tonnage of ore of higher grade and not risk such a large amount of capital investment. In view of the doubtful price of silver, the latter course was decided on.

In mining, this presented one particular difficulty. The lenses, although well formed in general, have poor walls which in many places give trouble. At practically no point in the vein are the high-grade lenses on either the footwall or hanging wall of the vein, and usually they have highly oxidized lean ore for their walls. In the narrower stopes many pillars are left, and many stulls and headboards placed to hold the hanging wall. These stopes are mined by the shrinkage system. The wider lenses are mined by the slot system. Here, on many occasions timbered slots are driven two sets long and from footwall to hanging wall at about 25-ft. intervals.

As mentioned previously, production was started Oct. 1, 1937, and the mine began delivering 130 tons daily at that date, with 50 tons being taken from an ore dump. By the end of October, 150 tons was being taken daily from underground operations and 50 tons from the dump. At the end of 1937 the mine was able to deliver the entire 200 tons.

In making plans for putting the mine in production it was decided to lay the project out with the idea of a probable increase in tonnage over the projected rate of 175 tons per day. Consequently, the crushing plant was designed for single-stage crushing, a 3-ft. Traylor crusher operating in closed circuit with a vibrating screen being used. Currently, crushing is done on one shift. In the event of an appreciable increase in production, the work can be done on two shifts with the same layout. However, if a considerable increase is desired, and it



THE FLOWSHEET of the Desert Silver cyanidation plant. Capacity, now rated at 175 tons daily, can readily be increased, if necessary

is found beneficial to feed the crusher larger and more material, the equipment is so arranged as to make possible the installation of a secondary crusher, the only auxiliary machinery required being a short conveyor to close the secondary crusher with the vibrating screen.

The mill was laid out so that in doubling its capacity the grinding unit, agitators, thickener, and filter can be duplicated conveniently and so placed that the present solution tanks and precipitation unit can be used for the entire mill, the only changes necessary being the matter of pumps, an extra clarifier tank, and another precipitation press. The air compressor furnishing air for the mine was installed at the mill, and for the following reasons: (1) The arrangement permitted the mill operators to attend to its operation and thus save labor expense, and (2) the discharge of the compressor is passed through coils in the barren solution tank heating the solutions and cooling the air for underground operations. Due to shortage of water, the cooling water of the mine compressor, mill compressor, and vacuum pump is used for spray water on the filter, excess water being discharged at the head pulley of the tailings stacker. Electric power for the plant is obtained at 12,000 volts from Nevada-California Electric Company's substation at Silver Peak.

The accompanying flowsheet indicates the flow of pulp and water and the different sizes of equipment. The floor area of the mill, exclusive of the crushing plant, is 9,568 sq.ft. The building is of timber construction covered with corrugated iron sheets, and is insulated with $\frac{3}{8}$-in. Firtex. Despite this construction, all surface structures carry a good fire-insurance rate. This is due to the fact that before construction of any of the buildings or pipe lines, the plans were submitted to the fire underwriters, and building clearances and the fire protection layout were made according to their recommendations.

A study of the flowsheet will reveal that the settling area provided in the thickener and filter area are smaller than usual. This because the ore settles unusually fast. Even with the small area provided, the filter and thickener equipment currently in use has been found satisfactory for a production rate of 200 tons per day, which is 25 tons more than the rated capacity of the mill. The fast settling rate is considered to be due to the fact that mining operations are not carried to the vein walls, all the ore being mined from lenses of ore within the wide vein.

Because of insufficient water, the tailings are stacked by means of a conveyor belt. It is expected that sinking operations now in progress will develop sufficient water to eliminate the necessity for such procedure. Besides one refiner and one crusher operator, the mill is operated by two men each shift, or a total of eight men. Currently, the silver precipitates are dried and shipped to the smelter, but it is expected that a melting furnace will be installed soon. The precipitates assay around 26,000 oz. silver and 60 oz. gold per ton.

Open-pit Transport on Mesabi Range

(*Continued from page* 47)

tons by using steam locomotives on stiff grades in a long narrow pit and had reached a depth of 350 ft. About 2,000,000 tons of ore was still available and some of it was tied up in track benches. As the average yearly production at this mine seldom exceeded 250,000 tons, a belt-conveyor system from the bottom of the ore to the railroad storage pocket on surface was installed.

This installation is good for 200 tons per hour with a maximum of 300 tons, or 700,000 tons for the season, operating two 8-hr. shifts 150 days. The 30-in. conveyor has a total length of 854 ft. on a 19 deg. 10 min. incline and is split in three sections, each 284 ft. long, driven at 350 ft. per minute by a 40-hp. motor. The location of the conveyor in the ore deposit holds the distance hauled in the pit to 1,200 ft., with an average of 600 ft. The ore is dug with a $1\frac{1}{4}$-cu.yd. gas shovel and hauled to the pocket by two 13-cu.yd. side-dump Athey wagons on steel crawlers, each pulled by an RD7 caterpillar tractor. The wagons dump on grizzly bars that feed the oversize to a crusher, all the ore going into a 1,500-ton storage pocket, out of which a pan conveyor regulates the feed to the 30-in. belt conveyor. As the lower end of the conveyor is at the bottom of the ore deposit, 40 ft. below the pit surface, ample headroom is allowed for the crusher, the pocket, and the pan feeder. As the pit deepens, the ore pocket will be reduced in height until the mine is exhausted. Advantages of this type of haulage are:

1. Tractors, wagons, and shovels are equipped with crawler traction, which not only eliminates all rail in the pit but insures continued operation in any weather, rain or shine.

2. When not busy hauling, the tractor can be used with a bulldozer for building roads, cleaning dirt from ore surfaces, and other pit jobs.

3. When diesel engines are used, the fuel costs on haulage show a worthwhile saving over gas engines.

4. Tractors and wagons require inexpensive road construction and practically no road maintenance.

In 1937, the Spruce mine, at Eveleth, not only installed an elaborate 30-in. belt-conveyor system for ore haulage but also tested under heavy operating conditions 20-ton gas-driven trucks as well as scraper-tower dragline haulage in the open pit. The conveyor system, of a rated capacity of 750 tons per hour, is almost 4,500 ft. long and the belt speed is 500 f.p.m. A profile shows how the belt follows the bottom of the ore deposit and discharges into a 500-ton shipping pocket for railroad cars on the surface; how the 20-ton trucks dump over bar screens and crusher into a pit-storage pocket; how the 100-ft. scraper gathering towers are set over a pocket and can rotate a full circle to care for an area of 600 ft. radius; how the 5-ft. (wide) variable-speed pan conveyors load the 30-in. belt at the bottom of the pocket, and how the three raises can serve the entire deposit effectively for loading, through the use of the trucks for the longer hauls and the clean-up. They also show how the belt system on the surface is housed in steel; how all the nine drive equipments, with 75-hp. 2,200-volt motors for each belt, are duplicates and operate through interlocking sequence to assure correct starting and stopping. The system operated over two months of the 1937 season and exposed its weak points in time for them to be corrected for this year's operation. These improvements consisted mainly in the substitution of washing of the return belts by spray nozzles in place of cleaning them by scraper and the installation of transfer chutes. Such experience benefits other operators on the range who learn what to prepare for under similar conditions.

The foregoing various types of haulage have been thus described in a general way to outline the practice on the Mesabi range and to point the trend for the future. With such a large number of pits, varying in shape, in depth, in ore content, and in water conditions, one can see that each pit has its own problems to be considered. A later article will show how these various problems are dealt with from the engineering viewpoint to give the operator convincing proof that the haulage method finally approved is the right one to adopt.

Summary of the

MARKETS

WAR CLOUDS over Europe, happily dispelled as the month ended, dominated the market in the last two weeks of September. The Czechoslovakian crisis came to a climax on Sept. 28, and, early on that day, because of a wide-open break in foreign currencies and mounting war-risk rates, business almost stopped. The situation cleared sufficiently on the last two days of the month to steady the market and divert attention to the more favorable aspects of the domestic scene. The business situation here, except for the foreign developments, remained encouraging. Consumption of copper, lead, and zinc continued upward.

The *E.&M.J.* index of non-ferrous metal prices for September advanced to 74.70, against 73.94 for August, reflecting moderately higher prices for copper, lead, zinc, and tin.

Domestic copper advanced to 10.375¢, Connecticut Valley, chiefly on favorable statistics. Sales for the month of September amounted to about 60,000 tons. As the month closed, the undertone was firm. Production is being increased, but the gain in output is expected to be moderate and not become a threat to the price structure. The unsettlement in export quotations late in the month was caused by the drop in sterling.

The feature in lead was the formation of a Lead Producers Association in London early in September to regulate production in the foreign field. Output abroad will be cut 10 per cent, which development steadied prices immediately. The uplift in London inspired buyers here to come in for a large tonnage. The price advanced 20 points to the basis of 5.10¢, New York. Foreign zinc also strengthened, as a reduced output of lead would remove a certain tonnage of "byproduct" zinc ore.

UNITED STATES MARKET

1938	Electrolytic Copper		Straits Tin	Lead		Zinc
Sept.	Domestic (a)	Export (b)	New York	New York	St. Louis	St. Louis
1	9.900	9.750	43.250	4.90	4.75	4.75
2	9.900	9.750	43.125	4.90	4.75	4.75
3	9.900	9.775	43.125	4.90	4.75	4.75
5	Holiday	9.775	Holiday	Holiday	Holiday	Holiday
6	9.900	9.850	43.000	4.90	4.75	4.75
7	9.900	9.850	42.750	4.90	4.75	4.75
8	9.900	9.850	42.925	4.90	4.75	4.75
9	9.900	9.875	42.750	4.90	4.75	4.75
10	9.900	9.875	42.750	4.90	4.75	4.75
12	9.900	9.900	42.750	4.90	4.75	4.75
13	9.900	9.900	42.650	4.90	4.75	4.75
14	9.900 @ 10.025	9.950	42.900	4.90	4.75	4.75
15	10.025	10.000	43.350	4.90 @ 5.00	4.75 @ 4.85	4.75 @ 4.85
16	10.025	10.100	43.500	5.00	4.85	4.85
17	10.025	10.125	43.500	5.00	4.85	4.85
19	10.150	10.175	43.700	5.10	4.95	4.85 @ 4.95
20	10.150	10.225	43.625	5.10	4.95	4.95
21	10.150	10.200	43.700	5.10	4.95	4.95
22	10.150	10.025	43.375	5.10	4.95	4.95
23	10.150	9.950	43.250	5.10	4.95	4.95
24	10.150	9.925	43.250	5.10	4.95	4.95
26	10.150	9.900	43.750	5.10	4.95	4.95
27	10.150	9.925	44.125	5.10	4.95	4.95
28	10.150	9.775	44.250	5.10	4.95	4.95
29	10.150	10.000	44.375	5.10	4.95	4.95
30	10.150	10.100	44.500	5.10	4.95	4.95
Average For month	10.028	9.943	43.369	4.998	4.848	4.846
Sept.	AVERAGES FOR WEEK					
7	9.900	9.792	43.050	4.900	4.750	4.750
14	9.910	9.892	42.788	4.900	4.750	4.750
21	10.088	10.138	43.563	5.042	4.892	4.883
28	10.150	9.917	43.667	5.100	4.950	4.950
Sept.	CALENDAR WEEK AVERAGES					
3	9.900	9.767	43.133	4.900	4.750	4.750
10	9.900	9.846	42.835	4.900	4.750	4.750
17	9.973	9.996	43.108	4.942	4.792	4.792
24	10.150	10.083	43.483	5.100	4.950	4.942

SILVER, GOLD, AND STERLING EXCHANGE

NEW YORK AND LONDON

1938	Sterling Exchange		Silver		Gold	
Sept.	"Checks"	"90-day demand"	(c) New York	London	London	(d) United States
1	4.854375	4.846875	42.750	19.2500	143s ½d	$35.00
2	4.850000	4.842500	42.750	19.2500	143s 4d	35.00
3	4.841250	4.833750	(e)	19.1250	143s 5d	35.00
5	Holiday	Holiday	Holiday	19.1250	144s 1d	Holiday
6	4.822500	4.810000	42.750	19.0625	144s 2½d	35.00
7	4.821875	4.810000	42.750	19.2500	144s 1d	35.00
8	4.826250	4.813750	42.750	19.3125	144s 1½d	35.00
9	4.820000	4.807500	42.750	19.2500	144s 1d	35.00
10	4.811250	4.798750	(e)	19.3750	144s 4½d	35.00
12	4.808750	4.795000	42.750	19.4375	144s 7½d	35.00
13	4.801250	4.787500	42.750	19.5625	144s 7d	35.00
14	4.796250	4.776250	42.750	19.6875	144s 11d	35.00
15	4.805000	4.787500	42.750	19.5625	144s 3d	35.00
16	4.797500	4.781250	42.750	19.4375	144s 8½d	35.00
17	4.793750	4.776250	(e)	19.5625	144s 9½d	35.00
19	4.803125	4.788125	42.750	19.2500	144s 7d	35.00
20	4.820625	4.811875	42.750	19.2500	144s	35.00
21	4.821250	4.808750	42.750	19.2500	144s	35.00
22	4.813750	4.800000	42.750	19.3125	143s 11d	35.00
23	4.797500	4.784375	42.750	19.1875	144s 6d	35.00
24	4.782500	4.763750	(e)	19.4375	145s	35.00
26	4.750000	4.725000	42.750	19.4375	145s 7d	35.00
27	4.738750	4.715000	42.750	19.1250	145s 6d	35.00
28	4.705000	4.675000	42.750	18.7500	147s	35.00
29	4.755000	4.740000	42.750	19.3125	145s 10d	35.00
30	4.822500	4.810000	42.750	19.2500	144s 1d	35.00
Average for Mo.	4.80240	.....	42.750	19.300	.....	35.00
Sept.	AVERAGES FOR WEEK					
7	4.83800	.....	42.750	.....	.....	.....
14	4.81063	.....	42.750	.....	.....	.....
21	4.80688	.....	42.750	.....	.....	.....
28	4.76458	.....	42.750	.....	.....	.....

Calendar week averages: New York Silver, Sept. 3rd, 42.750; 10th, 42.750; 17th, 42.750; 24th, 42.750.

(e) Not quoted; Saturday.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.325c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less than 1c. over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order effective Jan. 1, 1938, the U. S. Government's price on newly mined domestic silver was established at 64.64c. Handy & Harman's quotation for domestic silver, 999 fine, was 64⅛c. per ounce throughout September.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quotated by the Treasury, which at present is equal to $34.9125 per ounce.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1938 Sept.	COPPER Standard Spot	COPPER Standard 3 months	COPPER Electro Bid	TIN Standard Spot	TIN Standard 3 months	LEAD Spot Buyers	LEAD Spot Sellers	LEAD 3 months Buyers	LEAD 3 months Sellers	ZINC Spot Buyers	ZINC Spot Sellers	ZINC 3 months Buyers	ZINC 3 months Sellers
1	40.5625	40.7500	45.7500	192.7500	193.5000	14.0625	14.1250	14.2500	14.3125	13.1875	13.3125	13.4375	13.5625
2	40.3125	40.5625	45.7500	191.2500	192.2500	14.0000	14.1250	14.1250	14.2500	13.0000	13.0625	13.2500	13.3125
5	40.6250	40.8750	46.0000	192.0000	192.5000	14.0000	14.0625	14.1875	14.2500	13.0625	13.1875	13.3125	13.4375
6	41.1875	41.4375	46.5000	192.5000	193.5000	14.1875	14.2500	14.4375	14.5000	13.1250	13.1875	13.3750	13.4375
7	41.0000	41.2500	46.5000	190.7500	191.7500	14.6875	14.8125	14.9375	15.0000	13.1250	13.1875	13.3125	13.3750
8	41.1875	41.4375	46.5000	191.8750	192.7500	15.0000	15.1250	15.2500	15.3125	13.3125	13.3750	13.5625	13.6250
9	41.0000	41.3125	46.5000	191.5000	192.5000	14.9375	15.0000	15.1875	15.2500	13.5625	13.6875	13.8125	13.8750
12	41.3750	41.5625	46.7500	191.7500	192.5000	15.0625	15.1875	15.3750	15.4375	13.9375	14.0000	14.1250	14.2500
13	41.3750	41.6250	46.7500	192.2500	193.2500	15.3750	15.5000	15.6875	15.7500	13.9375	14.0625	14.1875	14.2500
14	41.4375	41.6875	47.0000	192.5000	193.2500	15.5000	15.5625	15.6875	15.7500	14.1250	14.2500	14.3750	14.4375
15	42.5625	42.7500	47.7500	195.2500	196.0000	15.7500	15.8750	15.9375	16.0625	14.2500	14.3750	14.5000	14.6250
16	42.6875	42.8125	47.7500	194.5000	195.5000	15.8125	15.9375	16.1250	16.1875	14.8125	14.9375	15.0625	15.1250
19	43.3750	43.5625	48.2500	196.2500	197.0000	16.1250	16.1875	16.2500	16.3125	14.7500	14.8750	15.0000	15.0625
20	42.8125	42.9375	48.0000	195.7500	196.5000	16.0000	16.0625	16.1250	16.1875	14.2500	14.3750	14.5000	14.6250
21	42.5000	42.6875	48.0000	195.2500	196.0000	15.8750	15.9375	16.0000	16.0625	14.3125	14.4375	14.5625	14.6250
22	41.8750	42.0000	47.0000	194.5000	195.2500	15.2500	15.3125	15.3750	15.4375	14.2500	14.3750	14.5000	14.5625
23	42.1250	42.1875	47.7500	194.0000	194.7500	15.0625	15.1875	15.1875	15.2500	14.0625	14.1875	14.3125	14.3750
26	42.6250	42.6875	47.5000	194.5000	195.2500	15.6875	15.7500	15.6875	15.8125	14.7500	14.8125	14.8125	14.8750
27	42.8750	42.8750	47.7500	195.0000	195.7500	15.3750	15.5000	15.4375	15.5000	14.7500	14.8125	14.8125	14.9375
28	43.1875	43.0000	48.2500	195.7500	196.5000	15.5000	15.5625	15.5000	15.5625	14.3125	14.4375	14.5000	14.5625
29	42.0625	42.2500	47.7500	195.5000	196.2500	15.6250	15.6875	15.6875	15.7500	14.6875	14.7500	14.8125	14.8750
30	42.2500	42.3750	47.5000	196.7500	197.7500	15.6250	15.6875	15.5625	15.6875	14.1875	14.3125	14.3750	14.5000
Average for month...	41.864	.....	47.148	193.733	.....	15.249		15.401		14.040		14.246	

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(Oct. 1, 1938)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	20c.
Antimony, domestic, spot, lb	11.75c.
Bismuth, ton lots, lb	$1.05
Cadmium, lb	65c. @$.95
Calcium, lb., ton lots 98 @ 99 per cent	75c.
Chromium, 97 per cent grade, lb	85c.
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	30c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$39.00
Quicksilver, flask of 76 lb., 100 flasks or more	$75.00@$76.00
Radium, mg. radium content	$40.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50 per cent, c.i.f. Atl. ports, long ton	$22.00@$23.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$5.25
Mesabi bessemer	$5.10
Old Range non-bessemer	$5.10
Mesabi, non-bessemer	$4.95
Lead (Galena) 80 per cent, Joplin, Mo., ton	$57.98
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52 @ 55 per cent	35c.
50 @ 52 per cent	35c.
44 @ 48 per cent	30c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$20.00
Domestic, 65 per cent	(a)$18.00@$20.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc, Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$32.00

(a) Prices at mines, small lots, usually several dollars less.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3c
Cobalt Oxide, 70 @ 71 per cent, lb	$1.67@$1.77
Copper Sulphate, 100 lb	$4.25
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk, ton	$13.00@$15.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$23.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	10½c.
Ferromanganese, 78 @ 82 per cent, gross ton	$92.50
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo contained.	95c
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.60

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 90 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$7.00
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.50@$7.50
Domestic, abrasive, 70 @ 84 per cent	$12.50@$15.00
Dalmatian, 50 @ 55 per cent	(a)$6.50@$7.50
French, 56 @ 59 per cent	(a)$7.50@$8.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in	15@40c.
2 x 2 in	30@60c.
3 x 3 in	75@$1.20
3 x 4 in	$1.00@$1.40
4 x 6 in	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12@12½c.
Silica, in bags, 325 mesh, ton	$18.00@$40.00
Sulphur, Texas mines, long ton	$18.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$21.50
Basic	$20.50
No. 2 Foundry	$21.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.25

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1937	1938	1937	1938	1937	1938
January	44.913	44.750	20.734	19.895	490.670	499.895
February	44.750	44.750	20.083	20.159	489.307	501.722
March	45.130	44.446	20.677	20.088	488.412	498.394
April	45.460	42.750	20.740	18.880	491.524	498.046
May	45.025	42.750	20.346	18.731	493.835	496.673
June	44.818	42.750	20.022	18.945	493.404	495.772
July	44.750	42.750	19.986	19.356	496.582	492.855
August	44.750	42.750	19.848	19.389	498.043	488.044
September	44.750	42.750	19.889	19.300	495.145	480.240
October	44.750	.....	19.942	.....	495.395	.....
November	44.750	.....	19.707	.....	499.467	.....
December	44.750	.....	18.835	.....	499.510	.....
Year	44.883	.....	20.067	.....	494.275	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1937	1938	1937	1938	1937	1938	1937	1938
January	12.415	10.198	12.112	9.908	51.497	41.387	56.288	45.387
February	13.427	9.775	13.828	9.525	59.225	39.597	64.013	43.563
March	15.775	9.775	16.590	9.496	72.339	39.772	76.167	43.582
April	15.121	9.775	14.692	9.443	62.506	39.306	66.614	43.408
May	13 775	9.375	13.999	8.801	61.118	36.668	63.684	40.852
June	13.775	8.775	13.492	8.500	55.696	35.235	61.409	39.417
July	13.775	9.585	13.817	9.573	56.412	39.744	62.807	44.405
August	13.775	9.900	13.926	9.844	57.143	40.591	63.595	45.909
September	13.530	10.028	12.984	9.943	52.989	41.864	58.966	47.148
October	11.838	.....	11.207	.....	45.384	.....	50.619	.....
November	10.797	.....	9.850	.....	39.321	.....	44.023	.....
December	10.006	.....	9.714	.....	39.946	.....	43.886	.....
Year	13.167	.....	13.018	.....	54.465	.....	59.339	.....

New York quotations, cents per pound. London, pounds sterling per long ton, (a) Bid quotation.

LEAD

	New York		St. Louis		London			
	1937	1938	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	6.000	4.870	5.850	4.720	27.272	27.150	16.135	16.253
February	6.239	4.632	6.089	4.482	28.319	28.328	15.402	15.525
March	7.190	4.500	7.040	4.350	33.027	32.979	15.992	16.075
April	6.175	4.500	6.025	4.350	26.014	25.878	15.579	15.623
May	6.000	4.400	5.850	4.250	24.000	23.891	14.210	14.376
June	6.000	4.148	5.850	3.998	22.878	22.759	13.969	14.012
July	6.000	4.882	5.850	4.732	23.932	23.703	14.921	15.034
August	6.452	4.900	6.302	4.750	22.606	22.670	14.371	14.480
September	6.400	4.998	6.250	4.848	20.990	21.044	15.249	15.401
October	5.740	.....	5.590	.....	18.259	18.318	.....	.....
November	5.033	.....	4.883	.....	16.706	16.714	.....	.....
December	4.875	.....	4.725	.....	15.905	15.994	.....	.....
Year	6.009	.....	5.859	.....	23.326	23.286	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

TIN

	Straits, New York		Standard, Spot, London	
	1937	1938	1937	1938
January	50.925	41.548	229.350	183.619
February	52.010	41.373	233.750	183.144
March	63.043	41.219	282.988	183.473
April	59.172	38.430	267.136	168.612
May	55.651	36.885	250.645	162.693
June	55.851	40.376	249.852	177.429
July	59.245	43.428	263.540	192.542
August	59.465	43.276	264.595	192.966
September	58.675	43.369	258.943	193.733
October	51.654	.....	223.869	.....
November	43.299	.....	190.477	.....
December	43.051	.....	190.449	.....
Year	54.337	.....	242.133	.....

New York quotations cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1937	1938	1937 Spot	1937 3 Mos.	1938 Spot	1938 3 Mos.
January	5.847	5.000	21.153	21.281	14.994	15.173
February	6.465	4.813	25.122	25.322	14.408	14.589
March	7.381	4.417	33.188	33.405	14.364	14.477
April	7.010	4.141	26.216	26.344	13.729	13.919
May	6.750	4.042	23.092	23.365	12.682	12.869
June	6.750	4.131	21.409	21.528	12.890	13.104
July	6.923	4.745	22.568	22.693	14.144	14.371
August	7.192	4.750	24.140	24.290	13.467	13.675
September	7.190	4.846	21.406	21.607	14.040	14.246
October	6.085	.....	17.722	17.955	.....	.....
November	5.630	.....	15.808	15.970	.....	.....
December	5.010	.....	15.274	15.429	.....	.....
Year	6.519	.....	22.258	22.432	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pounds sterling per long ton.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1937	1938	1937	1938
January	90.000	117.500	19.500	20.000
February	90.000	117.500	19.500	20.000
March	101.667	117.500	20.000	20.000
April	105.000	102.500	20.000	20.000
May	105.000	102.500	20.000	20.000
June	130.962	102.500	20.000	20.000
July	142.500	102.500	20.000	20.000
August	142.500	99.722	20.000	20.000
September	142.500	84.000	20.000	20.000
October	142.500	.....	20.000	.....
November	142.500	.....	20.000	.....
December	132.888	.....	20.000	.....
Year	122.335	.....	19.917	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound, average of producer's and plater's quotations.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1937	1938	1937	1938	1937	1938
January	14.130	13.750	90.250	79.240	50.400	36.000
February	14.563	13.750	91.000	76.455	64.364	36.000
March	16.375	13.750	91.778	72.444	58.000	36.000
April	16.043	13.654	92.000	71.019	58.000	36.000
May	14.830	12.460	95.520	74.640	54.800	33.400
June	14.702	11.731	96.654	80.731	53.000	33.231
July	14.803	11.030	93.904	76.860	50.115	36.000
August	15.327	10.880	91.423	75.500	51.000	37.000
September	16.555	11.310	89.020	74.420	51.000	39.000
October	16.935	.....	86.140	.....	48.560	.....
November	15.848	.....	83.435	.....	43.652	.....
December	14.144	.....	81.038	.....	38.385	.....
Year	15.355	.....	90.180	.....	51.773	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1937	1938	1937	1938	1937	1938
January	21.50	24.50	20.50	23.50	21.00	24.00
February	21.50	24.50	20.50	23.50	21.00	24.00
March	24.20	24.50	23.20	23.50	23.70	24.00
April	24.50	24.50	23.50	23.50	24.00	24.00
May	24.50	24.50	23.50	23.50	24.00	24.00
June	24.50	23.73	23.50	22.73	24.00	23.23
July	24.50	20.50	23.50	19.50	24.00	20.00
August	24.50	20.50	23.50	19.50	24.00	20.00
September	24.50	20.50	23.50	19.50	24.00	20.00
October	24.50	.....	23.50	.....	24.00	.....
November	24.50	.....	23.50	.....	24.00	.....
December	24.50	.....	23.50	.....	24.00	.....
Year	23.975	.....	22.975	.....	23.475	.....

Iron in dollars per long ton. F. o. b. Mahoning and Chenango Valley furnaces.

PERSONAL ITEMS

C. W. Hall, Portland, Ore., mining engineer, has opened an office in Boise, Idaho.

Charles E. Lawall has been appointed director of the School of Mines of West Virginia University.

E. Harrison, of Benguet Consolidated Mining Company, Philippine Islands, is in Australia on leave.

Louis J. Joubert, general manager of Bulolo Gold Dredging Ltd., is visiting the United States on vacation.

A. H. Flowerdew is returning to London after having bored alluvial areas in Victoria on behalf of Tronoh Finance, Ltd.

Lewis H. Boyd is directing development work of the Idaho-Nevada Copper Corporation, Ltd., near Mountain City, Nev.

W. T. Burnett, formerly surveyor at Mount Coolon, North Queensland, has accepted an appointment with Island Exploration Company, Daru, Papua.

John D. Galloway is now representative of the Mining Corporation of Canada in British Columbia. He is no longer associated with Reward Mining Company.

W. A. Hughes, district inspector of mines at Kalgoorlie, Western Australia, has resigned in order to accept appointment as director of mines, Northern Territory.

George A. Broomell is returning to Musoma, Tanganyika, British East Africa, on Oct. 5 from New York. He is geologist for the Soriano Interests in that area.

Herbert Witt, of San Francisco, has been in charge of extended prospecting work on scheelite claims in southern Nevada for the Goldfield Consolidated Mines Company.

Irvine M. Marshall, who recently resigned the managership of Sullivan Consolidated Mines, Ltd., has been appointed manager of Naybob Gold Mines, at Timmins, Ont.

James Hooper, formerly superintendent of the Elkoro mine at Jarbidge, Nev., for the Yukon Gold Company, is manager for the Owyhee River Copper Company at Mountain City, Nev.

A. M. Richmond, general manager of Consolidated Gold Alluvials of B. C., Ltd., has also been appointed manager of the Durango mine of Dentonia Mines, Ltd., at Ymir, B. C.

S. G. Blaylock, vice-president and general manager of the Consolidated Mining & Smelting Company of Canada, Ltd., for many years, has been appointed managing director. He entered the service of the company in 1899.

G. A. Roush, editor of "The Mineral Industry," completed his 25th year in that capacity, with the publication last month of Volume 46. He was appointed to this position in 1913, when he was associated with Dr. J. W. Richards in the department of metallurgy at Lehigh University. For 25 years he has selected authoritative contributors on various

G. A. ROUSH

mineral topics and has personally assumed responsibility for the preparation of material relating to strategic mineral supplies, on which he has become an authority. A recent evidence of the standing which Mr. Roush has attained as a spokesman for the mineral industries is his selection by the publishers of the Encyclopaedia Britannica to prepare for their new Britannica Book of the Year all of the articles dealing with mineral and metal topics. In the current volume of "The Mineral Industry" Mr. Roush has expanded the usual annual editorial summary to cover the 25 years of his editorship. The publishers are reprinting this summary as a separate, in order that the material may have a wider circulation than it would secure in the volume alone.

Richard F. Brown, until recently superintendent of the Oat Hill quicksilver mine, near Middletown, Calif., has joined the staff of the Manitou mine, Minto, B. C., Canada.

John K. MacGowan, for many years connected with mining enterprises and formerly a partner in Guggenheim Brothers, has been elected a director of Standard Gas & Electric Company.

William Sharp, field engineer during a number of years for the George Wingfield interests in Nevada, is in charge of work at Eureka, Nev., for the Eureka Corporation Ltd., composed of Canadian mining men with headquarters at Toronto.

F. A. Fournier, who for the past five years has been a member of the staff of Placer Development Company, has severed his connection with that company and returned to Vancouver.

G. Basil Blonsky, mining engineer, has left San Francisco to join the staff of the Gold Arrow Mining Company, which is reopening the Ophir and Canada mines near Rocky Bar, Idaho.

F. S. Mulock has been elected vice-president and general manager of the Western operations of the United States Smelting, Refining & Mining Company, with headquarters at Salt Lake City.

B. Zerbe, Sunshine Mining Company engineer, has gone to Mountain City, Nev., to take over engineering work at the La Grande Copper Company, in which Sunshine officials are said to be interested.

Fred Denton, formerly mine foreman at the New Brunswick mine of Idaho Maryland Mines Corporation, Grass Valley, Calif., has been appointed superintendent of the company's operations at Forbestown, Calif.

Owen B. Williams, general manager of Malayan Tin Dredging, Ltd., and Southern Malayan Tin Dredging Ltd., Perak, F.M.S., has returned to the East after several months' leave spent in Australia.

Andre Dorfman and **M. F. Fairlie,** of Toronto, president and consulting engineer respectively of Anglo-Huronian, Ltd., visited the Zeballos region of British Columbia recently to examine the Goldfield mine.

Thomas J. Thorne has left his post of mine engineer with Golden Queen Mining Company, Mojave, Calif., and is now mine superintendent for the Holmes & Nicholson Mining & Milling Company, Yuma, Ariz.

William H. McNair, long associated with the Goldfield Consolidated Mines Company of Nevada, is now at Fairbanks, Alaska, having been retained as engineer and assistant geologist for the Cleary Hill Alaska Mines Company.

L. D. Drake, metallurgical engineer, who recently joined the staff of Pan-American Engineering Company, Ltd., has returned to headquarters in Berkeley, Calif., after a protracted trip to Kimberley, B. C., and Eastern points.

H. A. Guess, of New York, vice-president of the American Smelting & Refining Company, and managing director of the Federal Mining & Smelting Company, visited the company's holdings in the Coeur d'Alene district early in September.

E. R. Borcherdt, who has been research engineer for the Butte mines of Anaconda, has been appointed to act in a similar capacity for all of the Anaconda subsidiaries, including Inspiration Consolidated, Greene Cananea, and Chile Exploration.

Merril E. Shoup has been elected president of the Golden Cycle Corporation, operating properties in Colorado. He succeeds **Leslie G. Carlton,** deceased. Other officers recently elected were **E. P. Shove,** vice-president and treasurer, and **J. F. Underwood,** secretary.

H. D. Bemis has been transferred by the American Metal Company, Ltd., from the position of mill superintendent at the Pecos mill, of the New Mexico unit, to the same position at the Matahambre unit, in Cuba. He was succeeded at Pecos by **Dean Oliver**, previously assistant superintendent and master mechanic.

H. L. Talbot has resigned his position as mill superintendent for Minas de Matahambre, of Cuba, and will sail in November to assume the duties of research metallurgist for Northern Rhodesia mining properties of Anglo American Corporation of South Africa, Ltd.

Otto D. Rohlfs, former general manager of Original Amador Gold Mines, at Amador City, Calif., and subsequently connected with the engineering staff of Marsman & Company, Manila, P. I., is now general manager of Quail Gold Mines, Inc., at Coulterville, Mariposa County, Calif.

R. S. Eskridge, consulting mining engineer of Seattle, Wash., has returned to his Seattle office from a trip to British Columbia. On his return he examined a property in central Idaho to determine its future development to find additional ore for its mill.

A. B. Jackson, at one time manager of the mining and metallurgical department of Hubert Davies & Company, in the Transvaal, has been appointed Canadian representative of a British engineering company. He has established headquarters at Montreal.

Col. D. C. Jackling, president of the A.I.M.E., attended a meeting and dinner of the Nevada section, members of which were guests of the Nevada Consolidated Copper Corporation at McGill on Sept. 17. **W. I. Smyth**, of the Mackay School of Mines, at Reno, chairman of the Nevada section, presided and **Tasker L. Oddie** welcomed the Institute president. **J. C. Kinnear**, manager for Nevada Consolidated, also addressed the meeting in his capacity as host. **A. B. Parsons**, secretary of the Institute, accompanied Colonel Jackling to Nevada.

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OBITUARY

James Watson Bradin, 3d, metallurgist and ore and metal broker, of New York, died on Sept. 5, at the age of 60.

Harry W. Finnell, a vice-president of Phelps Dodge Copper Products Corporation, died in New York on Oct. 1 at the age of 57.

Granville Lundy, superintendent of the Gold Bar Dredging Company, Lewiston, Calif., died on Aug. 15 of injuries received in an automobile accident.

John N. McLellan, superintendent, Auburn-Chicago mine, Auburn, Calif., died recently in an automobile accident near Newcastle, Calif. He was 55 years of age.

Lawrence Scotland, financial manager of the several companies directed by the late Sir Robert Williams, Bt., died recently at the age of 64. Mr. Scotland was widely known in London mining circles.

Sir Nowroji Saklatvala, chairman of Tata Iron & Steel Company, Jamshedpur, India, and chairman, also, of Tata's, Ltd., died at Aix-les-Bains, France, recently at the age of 62.

John H. Schofield, a veteran mining man identified with many large drift-mine operations in Sierra County, Calif., died recently at Downieville, in that county.

Charles A. Smith, general manager, Picacho Gold Mining Company, died recently in Los Angeles, Calif., aged 58.

Ellard Carson, from whom the Gould interests acquired the Klau quicksilver property at Adelaria, Calif., died recently at San Luis Obispo, in that state. Many years ago he operated the Almaden and Oceanic quicksilver mines.

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Letters

Operating Costs of Small Gold Mine

The Editor:

THE ARTICLE by Wiechmann and Becker (*E.&M.J.* p. 47, July, 1938) on operating costs of a small gold mine, is very interesting and instructive. It shows clearly that no empirical figure can be taken to represent costs of a small operation. As the authors of this article believe that the publication of costs by small mine operators would help the industry, I submit the costs of an operation where most of the conditions are favorable.

Fairview Amalgamated Gold Mines, Ltd., is almost ideally situated in the Okanagan Valley, British Columbia, for climate and for transportation of supplies and concentrates. The climate is sub-arid, and the railway is about five miles away, on good roads. Other favorable features are fairly wide orebody (about 15 ft.), very simple metallurgy, and high concentration ratio, about 100 to 1. The latter feature gives low marketing costs per ton of ore; and although cyanidation would be easy, it would not be warranted, on account of the low marketing costs now obtaining. Water for the operation is easily available, and West Kootenay Light & Power Company, Ltd., supplies all the power necessary at a very reasonable cost. Excellent ground in the mine and handy lumber help reduce mining costs.

Slightly unfavorable conditions include: transportation of ore from mine to mill $0.35 per ton; milling equipment which might be improved with a saving in grinding and power; lack of sufficient development ahead in the mine raises, drill holes, etc., to insure the most economical mining; mine haul is by horse train, and haul is direct 1,000-2,000 ft; milling is by direct flotation, and concentrates are shipped to Tacoma smelter. Grinding a quartz ore to 60 per cent minus-200 mesh liberates nearly all the metallic content.

In the accompanying table costs are arrived at in much the same manner as those cited by Messrs. Wiechmann and Becker, and in this case are for June, 1938.

The mill treats about 4,000 tons per month.

It will be seen from the tabulation that with gold at $35 per ounce the Fairview mine requires an average content of slightly more than 0.10 oz. gold per ton to cover operating costs. This does not include any amount for depletion.

It is estimated that by moving the mill to the mine portal, increasing the tonnage to 300 to 400 tons per day, developing the mine in advance of present needs, installing motor haulage and mechanical mucking, costs could be further reduced by $1 per ton.

Table of Costs

	Per Ton
Mining	$1.21
Hauling	0.35
Crushing and milling	1.21
Marketing	0.20
Development*	0.20
	$3.17
Tailing loss	0.44
	$3.61

* Over longer period.

J. A. MACKENZIE,
General Superintendent
Oliver, B. C.

Other operators of small gold mines are cordially invited to contribute data on this subject.—EDITOR.

▼

Operating Costs of Balatoc and Benguet

The Editor:

J. S. PETERSON, general superintendent of our Balatoc mine, has just called my attention to certain inaccuracies in the data on Balatoc mine as reported in the tabulation appearing at the bottom of page 82 of the May issue of *E.&M.J.*

You report an operating cost of 15.05 pesos as against our actual operating cost during 1937 of 13.242 pesos; and an operating profit of 14.73 pesos against the actual figure of 16.083 pesos. I have checked this over and find that the difference is due to the fact that you have included depreciation, depletion, and manager's bonus in the operating costs.

Likewise, and for the same reason, I note that the Benguet figures are given as 16.29 pesos operating cost and 15.36 pesos operating profit, as against the actual figures of 14.5897 and 16.4267 respectively. It should also be noted that Ipo and Cal Horr are operated by Benguet company.

A. F. DUGGLEBY
Second Vice-President,
Benguet and Balatoc Mining Company
Manila, P. I.

What Metal Statistics Show

LATE IN SEPTEMBER metal producers were relieved to witness the removal of the threat of immediate war in Europe and, therefore, had occasion to view the domestic outlook more cheerfully as far as metal consumption was concerned. Business and industrial activity is going forward at a better pace and metal statistics continue to show improvement. Prices for copper, lead, and zinc are higher, but are still generally considered low by the industry in view of present-day total operating costs. Consumption of copper is now estimated at a rate above 50,000 tons monthly, and shipments of lead and zinc continue in good volume. Some copper producers operating on a curtailed basis have increased production schedules and three mines of the Anaconda Copper Mining Company were reopened recently. St. Joseph Lead Company is now operating on a four-day week instead of six days every other week. The Morning mine, a lead-zinc producer of the Federal Mining & Smelting Company, reopened on Sept. 1. Prospects of settling the strike at the East Helena lead smelter appear brighter. It is estimated that about 6,000 men have been returned to work in the base-metal industry since Aug. 1, and prospects for continued employment through the winter months seem good in view of the statistical position of metals. Stocks of domestic refined copper declined 24,779 tons in August and another drop is expected for September. Total lead stocks declined 9,414 tons during August, and the drop in common grades of zinc was 11,254 tons in September.

As production of metals increases from now on, this position of the statistics will begin to be reflected in October and gradually approach consumption rates.

Domestic and foreign deliveries of copper since the beginning of 1938, in short tons, follow:

	Domestic	Foreign
January	24,881	114,647
February	27,389	110,796
March	33,434	125,269
April	31,684	129,577
May	28,044	108,523
June	32,863	112,530
July	41,249	126,533
August	48,071	129,509
Totals	267,615	957,384

Following is a summary of the figures of the Copper Institute for July and August, in short tons:

	July	Aug.
Production, blister:		
U. S. mine	25,539	36,561
U. S. scrap, etc.	5,616	8,204
Foreign mine	86,129	89,556
Foreign scrap, etc.	10,506	16,359
Totals	(c)127,790	150,680
Production, refined:		
U. S. duty-free	35,596	38,053
Foreign	103,887	110,855
Totals	139,483	148,908
Deliveries to customers, refined:		
U. S. domestic	41,249	48,071
U. S. export	13,348	14,761
Foreign	113,185	114,748
Totals	167,782	177,580
Stock at end, refined:		
United States	339,970	315,191
Foreign	183,226	179,333
Totals	523,196	494,524

(c) Corrected.

▶ LEAD—Stocks of refined lead in the hands of producers declined 13,494 tons during August, and another substantial decrease is expected for September. The drop in production is accounted for by the strike at the East Helena smelter, which has been effective since July 1.

The American Bureau of Metal Statistics' figures on refined lead for July and August, in short tons, follow:

	July	Aug.
Stock at beginning	163,346	154,231
Production:		
Domestic ore	27,976	23,723
Secondary and foreign	3,512	1,824
Totals	31,488	25,547
Domestic shipments	40,601	39,074
Stock at end	154,231	140,737

The following tabulation shows total lead stocks at the works of smelters and refiners in the United States so far as reported, in short tons:

	Aug. 1	Sept. 1
In ore, matte, process (a)	45,990	52,473
In base bullion:		
Smelters and refineries	12,640	12,345
In transit to refineries	1,395	1,356
In process at refineries	14,937	12,868
Refined lead	143,153	128,819
Antimonial lead	11,078	11,918
Total stocks	229,193	219,779

(a) At smelters.

Domestic lead shipments, by months, for 1936, 1937, and the first eight months of 1938:

	1936	1937	1938
January	34,590	45,718	34,923
February	33,086	50,375	30,135
March	36,743	63,425	31,052
April	40,457	55,200	25,952
May	33,125	55,212	26,011
June	37,736	42,710	35,343
July	38,996	47,727	40,601
August	46,388	54,551	39,074
September	50,685	53,850	.....
October	59,210	39,292	.....
November	50,313	33,853	.....
December	52,032	34,020	.....
Totals	513,361	575,933	.....
Monthly av'ge	42,780	47,994	32,886

▶ ZINC—The August and September statistics of the American Zinc Institute, covering all grades, are summarized as follows in short tons:

	August	Sept.
Production	32,296	32,328
Production, daily rate	1,042	1,078
Shipments	36,507	43,582
Stock at end	141,997	130,743
Unfilled orders	30,554	40,435

Statistics of the Prime Western division, common grades only, for July and August, follow:

	August	Sept.
Stock at beginning	63,855	57,529
Production	13,962	14,167
Shipments	20,288	19,486
Stock at end	57,529	52,210

The zinc statistics for August were revised by the American Zinc Institute, and the above table includes the corrected figures for that month.

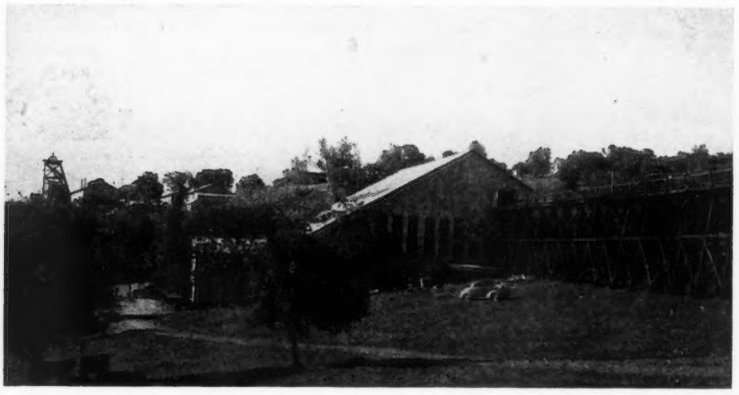
Silver Production of the World

The following statistics on world production of silver contain revised figures on Mexico's output for both April and June, as reported by the American Bureau of Metal Statistics:

(In Thousands of Ounces)

	Feb.	Mar.	Apr.	May	June	July	Jan.-July
United States	5,083	5,752	5,044	4,813	4,679	4,530	35,123
Canada	1,735	1,729	1,430	1,509	1,603	2,112	11,740
Mexico	7,144	8,803	7,153	6,244	8,417	(a)	(a)
Peru	1,351	1,380	1,350	1,525	1,300	1,900	10,306
Other America	1,450	1,575	1,525	1,500	1,475	1,470	10,635
Europe	1,600	1,635	1,600	1,675	1,675	1,700	11,555
Australia, refined	612	787	720	610	771	861	5,127
Other Australia and N. Zealand	500	425	450	525	590	500	3,440
Japan (b)	820	820	840	840	845	845	(c)5,830
Burma, refined	510	500	500	495	495	490	3,490
Other Asia	250	300	290	300	325	300	2,045
South Africa	85	97	95	99	95	97	664
Belgian Congo	250	250	225	225	210	210	1,620
Other Africa	75	75	75	80	85	85	550
Total	21,465	24,128	21,297	20,440	22,565	...	...
Total ex Mexico	14,321	15,325	14,144	14,196	14,148	15,100	102,125

(a) Not yet reported. (b) Owing to governmental interdiction the accounting for Japan is now necessarily on the assumption that it is being maintained about at prior rate. (c) Conjectural.



View of milling plant at the Gover-Fremont properties of Amador Mother Lode Mining Company near Drytown, Calif.

CALIFORNIA

Erin-Go-Bragh Mine Resumes Operations

Property has been acquired by Delgold Corporation—Increased mill capacity for Eagle-Shawmut mine—Kennedy Mining & Milling Company deepening shaft to 5,800 ft.

▶ Work has been resumed at the Erin-Go-Bragh mine by Delgold Corporation, which has recently acquired all assets of the California Standard Gold Mines Corporation, the former operators. The property is equipped with a modern flotation plant, and has produced some $250,000 in gold during the sixteen months of operation under California Standard management. The principal work in progress at present consists of surface trenching with power equipment as a preliminary to exploitation of large surface ore deposits by power-shovel methods to supplement underground mining operations. Charles B. Little, with headquarters in Los Angeles, is president of Delgold Corporation; H. M. Thompson, general manager; and William T. Warren, superintendent.

▶ Tuolumne Gold Dredging Corporation is actively exploiting a strip of gold-bearing placer ground near the town of La Grange. The new gold-placer dredge placed in operation a short time ago is a 12-cu.ft. unit of all-steel construction, welded, and manufactured by the W. W. Johnson Company, of San Francisco. It was financed under a $600,000 RFC loan.

▶ W. E. Wilson, of Redding, Calif., has leased the Hines-Gilbert mine, near Greenwood, El Dorado County, with construction of living quarters for workers now in progress. The property contains a ten-stamp mill, but arrangements have been completed to move a 200-ton flotation plant to the Hines-Gilbert from Arizona. The lease assigned to Wilson was originally held by Mrs. E. Morgan, of Auburn. The Paragon hydraulic mine at Forest Hill, Placer County, acquired under lease and bond by Wilson and associates from the King C. Gillette interests a short time ago, may be worked by hydraulic methods on completion of the Ruck-a-Chucky débris dam to be constructed soon.

▶ The old Green Mountain mine, near the Murchie mine, in the Nevada City mining district, has been reopened by the Kistle brothers, Charles and Norman, who are driving a tunnel to develop a vein extending through the property for some 1,900 ft. A five-stamp mill is to be installed soon.

▶ A comprehensive development program has been started at the Three Kings mine, near Alleghany, Sierra County, by Ted Le Maire and associates, of San Francisco. A crew of ten men is engaged in driving a tunnel to contact ore disclosed by previous diamond-drill work. Operations are directed by William Morrison, R. Stapleton, and A. H. Walker.

▶ Milling capacity is to be increased to 350 tons, or more, at the Eagle-Shawmut mine, near Chinese Camp, by the addition of new crushing, grinding, and flotation equipment. The property is operated by Horace G. Miller and George W. Clemson, both of Los Angeles, with current production reported at 180 tons. Operations are directed by F. H. Mitchell, general superintendent.

▶ According to a report from Mojave, the J. J. Rascob interests, of Reno, Nev., have acquired the holdings of the Rivera Mining Company, Rogers-Gentry Mining Company, and the McIntyre estate, in the Neenach mining district near Lancaster, and development work is to start at once under the direction of W. J. Rogers. A substantial tonnage of good ore has been shipped to different custom mills in the district in the past.

▶ Good progress is being made by the Virgilia Mining Corporation in increasing the capacity of its flotation mill from 125 to 300 tons. The property is near Virgilia, Plumas County, and M. I. Sullivan, of San Francisco, is president of the corporation.

▶ Milling operations are now being conducted on a three-shift basis at the Malvina mine of Boston California Mining Company, Coulterville, where a 100-ton flotation mill was completed recently. The property was reopened in 1934 by Charles H. Segerstrom, of Sonora, president of the company, and underground operations are conducted through a three-compartment shaft 1,000 ft. deep. Nineteen men are now employed, but this figure will be increased to 35 as underground activities progress. Ed Mann is superintendent.

▶ The mill at the German Bar mine, on the Middle Fork of the Yuba River, in the North Bloomfield area, has been rehabilitated under the direction of Western-Knapp Engineering Company, of San Francisco, and is ready for operation. The plant was damaged by high water last winter, causing a loss estimated at $7,500. A retaining wall to protect the mill from future floods is now in course of construction. Underground extensive development continues, with Thomas E. Stephens in charge.

▶ At the property of Kennedy Mining & Milling Company, Jackson, Amador County, a crew is at work deepening the main shaft another 300 ft., to about 5,800 ft., with two additional levels to be established at 150-ft. intervals (vertical) to develop and prove the extent of an orebody discovered on the 5,550 level. William Sinclair is superintendent, and E. C. Hutchinson, with headquarters in San Francisco, is president of the company.

NEVADA

Development Planned on Claims Near Rio Tinto Mine

Rio Grande Copper Company acquired by Idaho group—Eastern Exploration Company relinquishes lease on Goldfield properties—Getchell Mine, Inc., pays first dividend

▶ Control of the Rio Grande Copper Company, with a large group of claims adjoining the Rio Tinto mine of the Mountain City Copper Company, in northern Elko County, has been acquired by an Idaho group headed by R. M. Hardy, president of the Sunshine Mining Company, foremost American silver producer. The new directorate includes some of the former Nevada officers. B. K. Zerbe, formerly superintendent at the Sunshine mine, has assumed charge of the Rio Grande and said that larger equipment would be provided and the shaft, now at the 285-ft, point, will be sunk to 500 or 600 ft. J. A. Davidson, of Mountain City, one of the locators of the claims, continues as president, and Frank L. Middleton, of Reno, United States marshal for Nevada and one of the largest of Rio Grande stockholders, remains as vice-president.

▶ An increasing volume of custom ore is being treated by the 150-ton cyanide mill of the Dayton Consolidated Mines Company at the outlet of Gold Canyon, a mile below Silver City, in Lyon County. For the past four and a half years the mill has operated at capacity on ore from the Dayton and Kossuth mines and

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from leased properties including the Justice and Keystone. The company has lately taken a lease on the Oest mine, near Silver City, a former producer from surficial workings, and leases will be granted in this territory. Homer L. Gibson, of Silver City, is president and managing director and William J. Henley, secretary and manager.

▶ Having provided two larger filters and effected other mechanical changes in its plant, Getchell Mine, Inc., has been treating 600 to 700 tons of ore per day at its property 25 miles north of Golconda, in Humboldt County. Three-fifths or more of the mine product is oxidized ore, treated by direct cyanidation; the remainder, a heavy sulphide, is given a preliminary roast, passing from the calcining Gould furnace to a ball mill, and thence to the cyanide circuit. The mill is expected to handle 800 tons per day soon. Noble H. Getchell is vice-president and manager. Late in September the company paid its first dividend of 5c. per share.

▶ Core drilling is in progress under contract on property of the Idaho-Nevada Copper Corporation, Ltd., adjoining the Rio Tinto mine of the Mountain City Copper Company. The first drill hole was reported at around 250 ft. in quartzite, the core having shown some chalcopyrite. President James O. Galloway, of Boise, Idaho, has let a contract to Jack Dir, also of Boise, for drilling 2,000 ft. in several holes. L. H. Boyd is in charge for the company.

▶ Eastern Exploration Company, wholly-owned subsidiary of Calumet & Hecla Consolidated Copper, has relinquished its lease and option on the large Goldfield properties of the Goldfield Consolidated Mines Company, and its engineering staff has disbanded. During something over two years of operation, the leasing company is said to have produced around $1,000,000 in gold ore that was shipped to smelters in Utah. The purchase price under the option was $500,000, and it was reported that approximately $250,000 had been paid to the Goldfield company in royalties. J. Gardner Edwards, in charge for the Calumet & Hecla, has returned to Houghton, Mich.

▶ A gold property known as the Prospector's Friend mine, in northern Churchill County, owned by former United States Senator Tasker L. Oddie, of Nevada, and Fred H. Luetjens, of Reno, has produced some ore of high grade that has been trucked to the custom mill of the Dayton Consolidated Mines Company near Silver City.

▶ Control of the Rip Van Winkle silver-lead mine in the Lone Mountain district, northwest of Elko, has been acquired by a Utah group including certain officers of the Utah Copper Company, and a flotation mill is soon to be provided, according to a report from Salt Lake City.

▶ The Wall Street mine, in Eldorado Canyon, is maintaining steady production from a blanket vein employing the room-and-pillar system of mining. About 40 tons of gold-silver ore are treated daily in a flotation plant equipped with amalgamators. A. E. Place is in charge of operations.

The Morning Mill of the Federal Mining & Smelting Company, near Mullan, Idaho. The company closed the Morning mine, a lead-zinc producer, on June 25, and resumed operations on Sept. 21. Concentrates will be accumulated at the above plant and later sent to the East Helena lead smelter

IDAHO

Reopening Morning Mine Aids Employment

About 600 men brought back to work—Activity increasing in Central Idaho—Terrible Edith mine resumes operations

▶ The Morning mine of the Federal Mining & Smelting Company, closed since June 25, resumed operations in all departments on Sept. 21. H. G. Washburn, general manager, said that all lead concentrates will be stored at the mill as long as the East Helena, Montana, smelter strike is on. Some 600 miners returned to work, most of them idle since the mine shut down. Production from the Page mine and mill of the company will also be started.

▶ Terrible Edith, Midland Mining Company's property in the Murray district, resumed operations this month, according to Manager H. C. Stapleton, of Murray. The shaft is being unwatered and will be deepened. Development has disclosed a good showing of lead-silver ore in the shaft.

▶ Sunshine Mining Company recently declared a 60c. dividend, totaling nearly $900,000, payable on Sept. 30. Manager Ross D. Leisk said that diamond drills had opened the Sunshine orebody on the 3,100-ft. shaft level with the cores revealing a high silver content.

▶ Diamond-drill operations at the Atlas mine, near Mullan, have disclosed a good showing of lead-silver ore, according to W. Earl Greenough, of Mullan, president. A crosscut is now being extended to the ore showing.

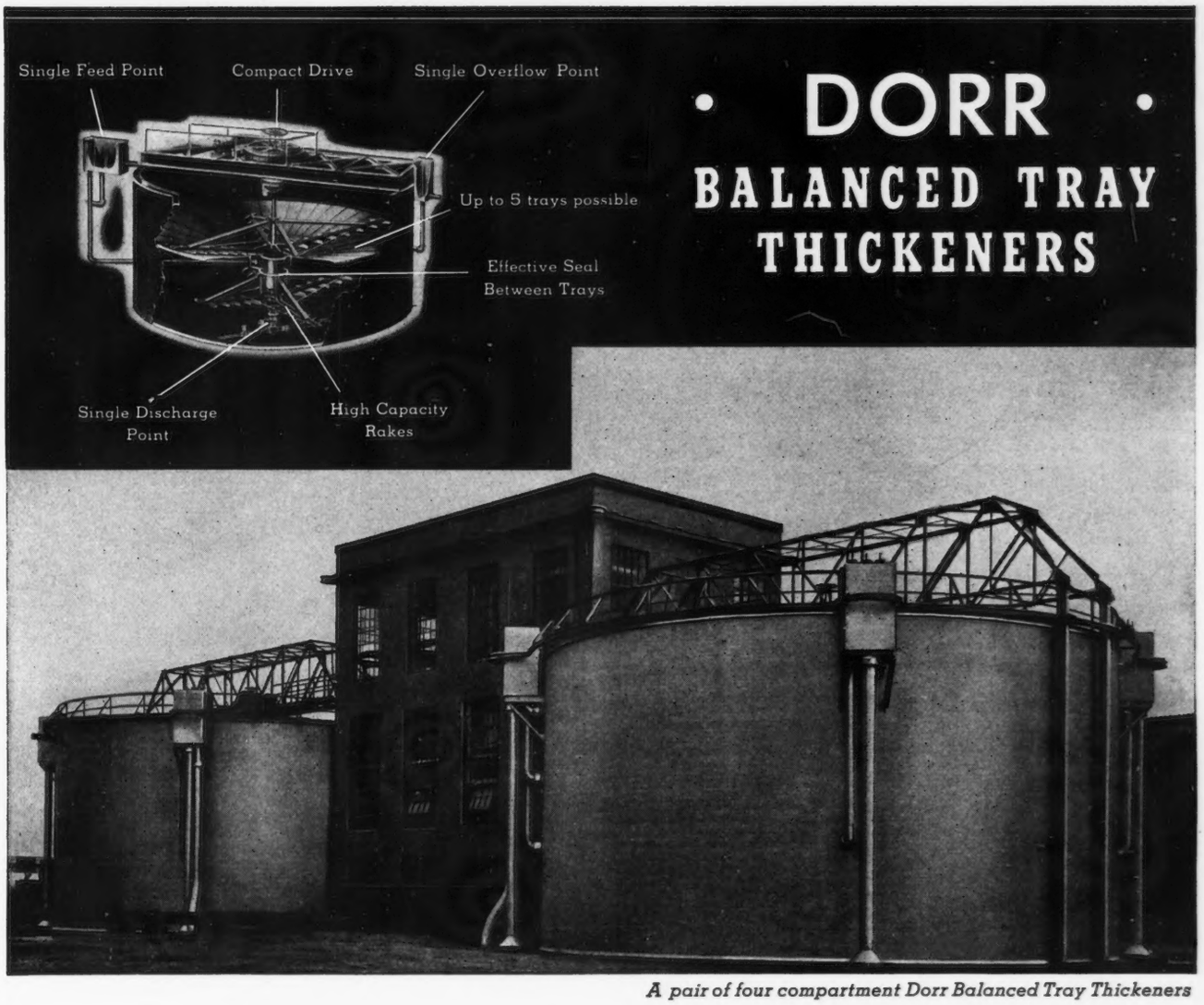
▶ Bunker Hill & Sullivan, at Kellogg, reported net profits of $388,281 during the first seven months of the current year. No dividend on common stock has been declared this year. During its 50 years of activity the Bunker Hill has paid total dividends of $51,516,750 on common stock and on the preferred, $739,642.65.

▶ Mines in central Idaho are booming, with more activity shown than in many years. The Lindy group of gold claims, in the Mineral Hill district, has been leased by Lloyd A. Pratt, of Pomona, Calif. American Gold Mining Company plans to increase its mill capacity to 30 tons a day on the property near Dixie, according to Superintendent Frank Maguire, at Dixie. Gray Mule mine, at Hailey, has reported surface ore valued at $180 per ton, principally in silver. Producers Mines, Inc., at Chloride, Ariz., have leased the property. I. D. Theriault, of Shoup, has leased the mine and 100-ton flotation mill of the Old Kentuck group on the Salmon River, from the Gold Hills Mines, Inc. Golden Hand mine, in the Ramey district of the Salmon River, will install a new ball mill to increase production from 10 to 20 tons per day, according to C. W. Mason, president, of Tacoma, Wash. At Goodenough United, in the Marshall lake district near Burgdorf, eight men are working under the Two Margarets Mining Company. A new compressor will be installed soon, the superintendent, Rube Fields, of Burgdorf, reported. Mountain Chief property, in the Pistol Creek district near Cascade, has a new 50-ton mill ready for installation.

▶ The Silver Summit shaft, in the Coeur d'Alene silver belt, is down 375 ft. on its way to the 1,000-ft. level, according to Manager Harry P. Pearson, of Wallace.

▶ Robert C. Moffitt, of Seattle, has been in the Coeur d'Alene district demonstrating his new electric rock drill. The machine weighs 350 lb. and is said to operate at full speed by a 5-h.p. motor, doing work equivalent to a drill driven by a 50-h.p. air-compressor unit. The drill has no exhaust, and with coarse cutting is said to eliminate the dust and oil problem.

▶ Metropolitan Mines Corporation was recently granted clear title to a group of claims in the silver belt in a decision in a suit against the Lincoln Mining Company.



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IDAHO

▶ Callahan Consolidated Mines, Inc., is advancing its deep Red Monarch crosscut at the rate of 6 ft. per day, according to Contractor Joe Grismer, of Wallace. A raise will connect the crosscut with the upper levels of the Rex holdings.

▶ Adam Patterson, Jr., of Ogden, reports that the Grimes Homestake Gold Mines Consolidated, financed by Utah capital, is mining ore in Boise Basin from its No. 2 Gold vein. The vein, which is about 4½ ft. wide, has been opened up for 225 ft. underground and by trenching 1,200 ft. on the surface. Metaliurgical tests of the ore were made by R. L. Kidd, formerly of the University of Utah, at the mill of the Mineral Mining Company, 2 miles distant. About $10,000 in gold bullion and concentrates was produced during the summer as the result of the tests.

ARIZONA

Pilgrim Mine Crushing Plant Nears Completion

Company plans to accept custom ore in addition to treating its own production—Operations at Copper Queen smelter increase—Asbestos deposits near Globe have chance for development

▶ The Liberty Hills Gold Mine, Ltd., is operating its 75-ton cyanide plant steadily at the Alvarado mine, near Congress Junction. The width and value of the ore is reported to be increasing with depth. L. L. Franham is general manager.

▶ Consolidated Gold Mining Company, at Dos Cabezas, is treating about 750 tons ore monthly in its new mill. About fifty men are employed. A. B. Wadleigh is superintendent.

▶ Gallup Gold Mine Company, near Kirkland, started operation of a 100-ton cyanide plant at the old Hassayampa Gold property Sept. 15. The company has a lease on the old workings and is rehabilitating the property.

▶ Emery Blevins, of Kingman, owner of placer properties in the Cave Creek district near Quartzite, has developed sufficient water for operating purposes in a drilled well at a depth of 80 ft. The drill hole will be followed with a shaft, and arrangements for water storage are planned. The property is held under lease by California interests.

▶ A custom asbestos fiberizing mill is nearing completion at Globe to aid a number of small asbestos producers situated near there. The mill will handle crude asbestos, converting it into fiberized product for shipment to Eastern markets. W. B. Harris, who formerly operated a similar mill in Los Angeles, is in charge of operations. Several small properties north of Globe are expected to keep the new mill supplied with asbestos mineral.

▶ E. W. Miller is operating the Allison mine, near Sells, under lease with a crew of six men. The property is owned by the Tom Reed Gold Mining Company, of Oatman, and the Allison Gold Mining Company, of Pasadena, Calif.

▶ George Taylor, a Phoenix cattleman, hired a well driller to drill for water on some grazing lands about six miles southwest of Superior. The driller found plenty of water, but he also reported that at 185 ft. he had encountered copper ore which continued for a thickness of 38 ft. The ore is said to have been high in copper and silver and also contained gold. This was two years ago. The report finally reached interested parties and another hole was drilled a short distance from the original well. At 210 ft. similar ore was discovered, but values were slightly less than found in the first drilled hole. Now the Rich Hill Mining Company is sinking a shaft to prove further the findings of the drillers. A. L. Lampton, formerly of Cleator, and Tom Higley, are in charge of the work.

▶ Phelps Dodge Corporation has started up a third furnace at the Copper Queen smelter. Another 100 men have been added to the payroll. H. M. Lavender is general manager.

▶ Gold Queen claims in the Dripping Springs section 25 miles south of Globe have been equipped with compressor, hoist, and drills. The ore is said to have a value of about $40 per ton. The property is owned by Richard and Steve Cochrehan, of Globe, Arizona.

▶ The enlarged crushing plant of Producers, Inc., on the old Pilgrim mine, west of Chloride, is practically completed. Daily production will be increased from present rate, about 200 tons, to 300 tons. Ores from the Pilgrim, Klondyke, and Scout properties are now supplying the cyanide plant. The company plans to accept custom ores for treatment from nearby properties, thus offering claim owners opportunity for greater development. H. W. Thorne, president, and A. M. Davis, vice-president, are in charge of operations.

▶ Arizona Magma Company, at Chloride, celebrated its third year of steady production recently. The mill has a continued operation record of 95 per cent of elapsed time and has increased daily output from 50 tons to 85 tons without installation of additional equipment. Recovery is reported to be 94 per cent saving of the gold and 96 per cent of the silver. The mill is handling about 2,500 tons monthly and a crew of 50 men are employed in mine and mill.

▶ Two drifts are being run on the 500-ft. level of the Trench silver-lead mine, at Patagonia, by the American Smelting & Refining Company. A raise is being driven from the 500- to the 300-ft. level. The station on the 700-ft. level is being enlarged and drifting will be started from here soon. About 50 men are employed at present. B. R. Hatcher, division manager, Tucson, is in charge of the work.

▶ The new 150-ton mill under construction at the property of the Iron King Mines, Inc., at Humboldt, is nearing completion. The company has been shipping about 4,000 tons ore monthly for the past twenty months. Development work has blocked out sufficient ore for steady operations for a long period. The company is sinking from the 500 level, and development work is confined above the 400 level. H. F. Mills is general manager.

▶ The Yellow Jacket and Bartlett claims located near Arivaca are being developed under lease by the North Star Mines, Inc. A mill is being erected. The company plans to enlarge two single compartment shafts to two-compartment size. L. A. Cole is superintendent.

▶ The Universal Placer Mines Corporation, at Wickenberg, is testing out a new dry separating process. The company has under lease the Thunderbird placer, near Congress Junction. Rupert P. Schaeffer, Jr., is president of the company, and offices are at 1421 Chestnut St., Philadelphia, Pa.

UTAH

Large Mill in Ophir Canyon Near Completion

International Smelting Company is constructing flotation plant for treating tailings—Labor contract still unsactioned by executive committee—Utah vehicular tunnel ready about Nov. 1

▶ One of the most encouraging signs in recent months was the resumption by the International Smelting Company of construction work at its flotation plant in Ophir Canyon. The mill, having a capacity of 600 tons daily, and costing about $130,000, will treat 400,000 tons of tailings left by the old Ophir Hill Consolidated mill. Ryberg Brothers, Salt Lake contractors, have the contract. Work is about 40 per cent complete. Operations are to start in 60 days. A 6,000-ft. flume for the disposal of tailings is being built and machinery installed. Tailings will be hauled to the mill on a contract basis. Concentrate will be hauled to the Tooele lead smelter of the company by railroad from St. Johns.

▶ Mine operators refused to reopen negotiations on a labor contract with members of the International Union of Mine, Mill and Smelter Workers. Months of negotiations have been stalemated by the action of the executive board of the union refusing to sanction the two-year contract, increasing wage scales and giving members other substantial gains.

▶ The Creole Mine, in the Stateline mining district, 20 miles northwest of Modena, in Iron County, recently shipped a carload of ore carrying 1.06 oz. of gold and 5.69 oz. of silver to the ton to a Salt Lake Valley smelter. Operated on a lease by Frank Wiece, it is said the property has produced $40,000 since 1935.

▶ The Utah Copper vehicular tunnel is being concreted, preparatory to its opening for use about Nov. 1. Churn-drill holes are being put down in the line of the Elton tunnel of the National Tunnel & Mines Company to ascertain where the solid formation lies.

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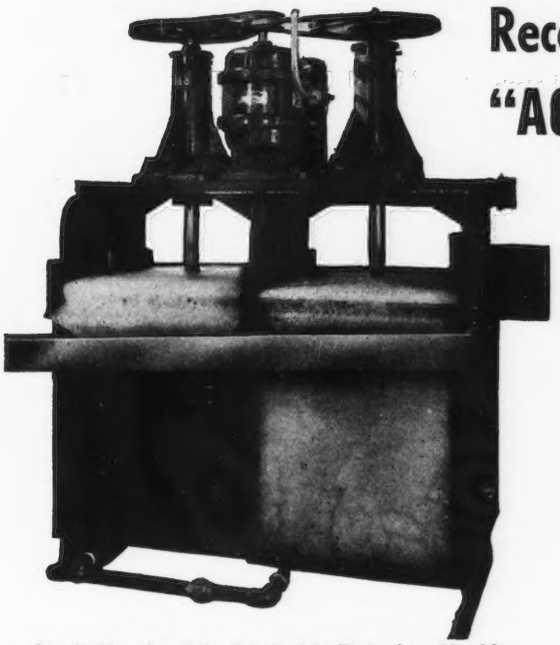

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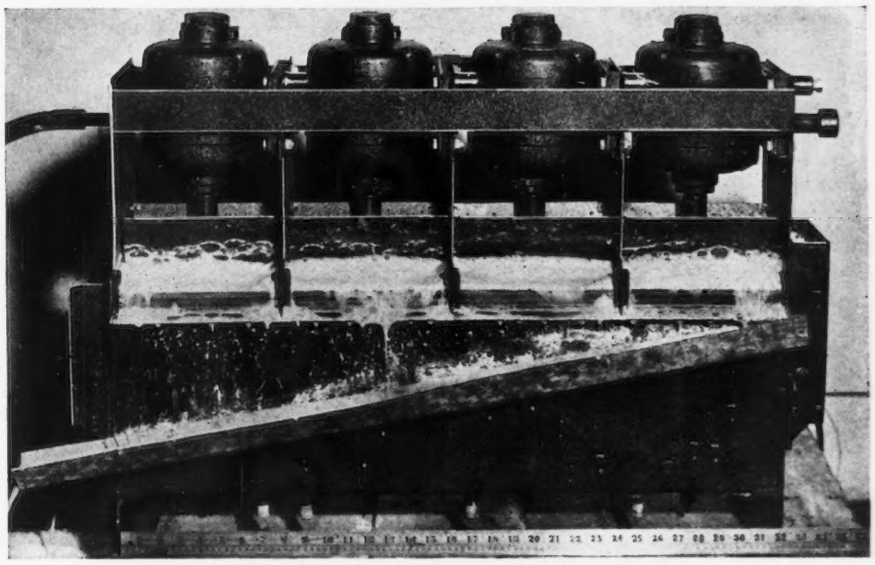

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NEWS FROM Washington

By Special Correspondent

IT IS EXPECTED that Congress will consider more seriously during the next session the mineral stockpile bill, the Thomas bill, S. 4012 of the last Congress. (See *E.&M.J.* June, page 68, and July, page 72.) The military authorities and the civilian bureaus of the Interior Department were greatly disappointed that it failed of serious consideration last spring. There is some question whether building such a stockpile will now be at all possible. But a provision that the military authorities *may* do so, and that the civilian bureaus may investigate domestic substitutes, seems logical because of the extreme strain of recent European events. The second provision is equally important with the first because domestic resources should be determined and used wherever possible.

Two factors working against the building of reserves of strategic minerals are noted. The foreign policy at the State Department is the most conspicuous of these influences. That Department apparently seeks to use the control of mineral movement as a leverage in trade negotiations. Some recent episodes have aroused indignation among industrialists visiting Washington. Whether correctly reported or not, these episodes furnish the basis for the charge that the State Department lags far behind other interested departments in support of real preparedness.

The other factor handicapping those who seek to build stockpiles is the frequent turnover of executive personnel in high positions of the Army and the Navy. Unfortunately, this year has ended the tour of duty of a number of officers who have distinguished themselves in furthering the Army and Navy plans for adequate military reserves. Thus, newcomers must take up the difficult problem at a crucial time, unprepared by real experience in solving these complicated questions. When representatives of the mining industry come to Washington they will have to start all over in educating these officers newly stationed at "strategic mineral" desks.

Ex Parte Judge

THE ACCEPTANCE by President Roosevelt of the idea that the National Labor Relations Act requires revision has encouraged much Washington discussion on that subject. There are at least a half dozen ways in which the mining industry would welcome a change. None of these is more important than the idea of putting NLRB onto a neutral judicial footing instead of its present *ex parte* status, more or less a private policeman representing organized labor. That change is, however, one of the most difficult ones to get, and is not really expected by the more realistic Washington forecasters.

Other changes in the act would seem a bit more likely of achievement, including: (1) Permitting the employer to request intervention in a labor dispute, a privilege now available only to employees; (2) forbidding coercion from any source, with the intention of relieving employees from the compulsion to join unions with which they do not wish to affiliate; (Congress might be willing to do this if it knew how to define "coercion.") (3) some provision for protection of minority groups of employees who form a bona fide organization and are opposed to the majority organization; (4) a definition of strikes which are legal and those, like the ultra "sitdown," which should be defined as "illegal"; (5) forbidding of the check off or closed-shop contract in the extreme form, where the employer is made virtually an agent of the union; (6) an effort to make NLRB an investigative and prosecuting agency without its present quasi-judicial powers. (This last is *most* unlikely.)

The officials of A. F. of L. will go the limit in affiliation with business spokesmen who want NLRB sharply curbed. Some political prophets think that the failure of C.I.O. to exhibit much ballot-box strength will give the business Federation combination considerable power with Congress; but more realistic observers expect only mild revision of the law next winter. In substantial measure this forecast is based on the fact that NLRB is itself curbing some of its more partisan staff members and "occasionally giving the break to someone besides C.I.O."

Low-Grade Ore

STUDYING THE FUTURE of mining employment, the W.P.A. reemployment research project in coperation with the Bureau of Mines has prepared a report on "Grade of Ore," a study of mineral technology and the output per man. One of the most significant parts of this from the standpoint of mineral economics is the generalization on the trend to declining concentration of values in metal ores. The following paragraphs from Chapter 1 of this document show the trend of official thinking:

"Under the stimulus of keen demand and the quest for profits, mine operators developed a skillful technology which brought into production the large-tonnage, low-grade deposits which resulted in a decline of the average yield of metal per ton. This tendency toward a declining grade of ore with increasing quantity of production is one of the principal features of the long-time mining process. Minor examples of the inverse relation that yield bears to tonnage appear whenever selective mining has raised the yield per ton. Major examples are shown in the long-time trends for each ore, as yield declined sharply at first and then sloped more gently under the influence of controlled mining.

"The cream of a mineral deposit is shallow, and once it has been skimmed during early exploitation, changes in valuable content are more gradual. There appears to be a characteristic range of grade for each stage of production, and it is significant that this range of grade has been continuously lowered over a long period.

"The relation indicated between declining tenor and ore tonnage is not precise and cannot be expressed as a simple mathematical formula, for descent of grade is not uniform. The rate of decline, for example, varies from time to time and is greater in some kinds of ore than in others; it differs, too, in the several regions and districts. Hence movements of yield for the United States ores of any given sort represent composite trends and are made up of the variously moving regional trends of grade. Their meaning is not made clear until regional movements are analyzed, and in some instances analysis must even be extended to certain important camps in a region before the bearing of the details on the general trend can be made out."

Benefits of Technology

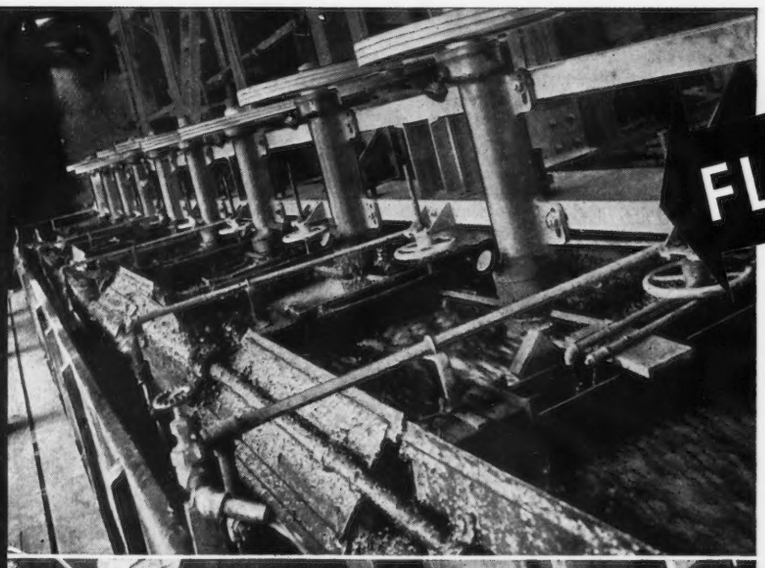
IN THIS SAME REPORT an effort at forecasting brings about strong emphasis on the importance of technology in developing low-grade ores which are essential if adequate mineral supply is to be provided. The official comment is:

"Further efficiencies in recovery will be purchased at a cost of greatly increased technological effort because the margin for potential improvement has greatly narrowed, but they must be achieved if lower-grade and more complex ores are to be utilized to meet the Nation's demand for metals.

"With larger doses of technology, additional gains should be made in recovery processes, although the improvements will probably take place at a slower rate in the future than in the past 35 years. A part of these savings will doubtless be plowed into the mining of lower-grade ores.

"There seems, therefore, little escape from the prospect that future metal mining must adjust itself to lowering of grade of ores. Copper reserves in ore of present workable grade are roughly sufficient for 40 years at the ten-year average of demand; it is anticipated that within this period the bulk of copper production will shift rather more completely to the low-grade porphyry deposits. There is roughly a 20- to 25-year supply in lead and zinc ores of present standards. The decline of output from the higher-grade vein lead mines of the West, where the reserves of ore of current grade are relatively small, will place a larger burden of production on the lower-grade ores of the Central States. Also, in the southeast Missouri and Tri-State regions, the present boundaries of the orebodies grade into subore that might be made to yield its lower metal content either by higher prices or by definitely less costly mining and recovery techniques. There are even

DENVER EQUIPMENT



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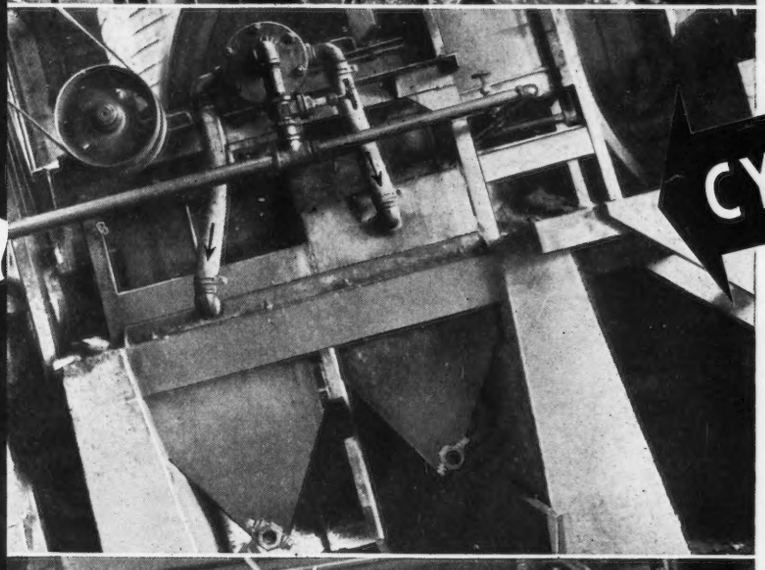

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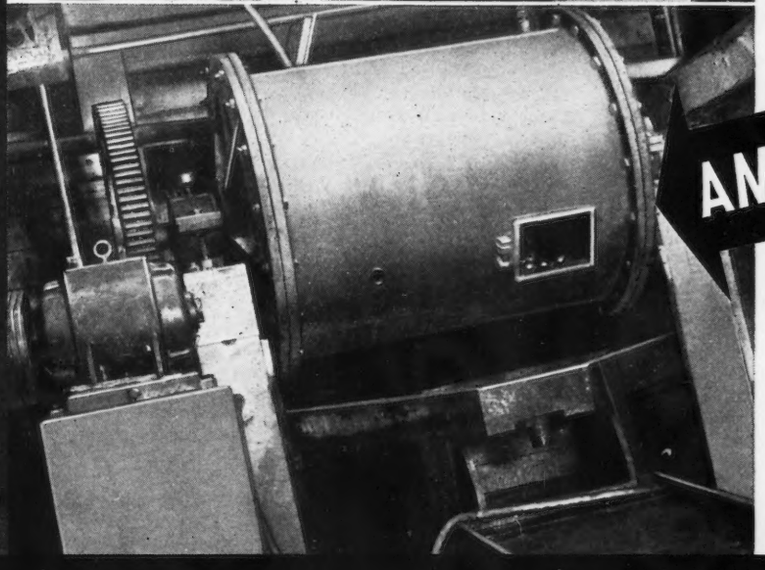

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larger and more widely scattered reserves of submarginal zinc ores."

(Editorial Note: Mine executives will want to get this document, which is Report No. E-6, entitled "Grade of Ore," issued by Works Progress Administration. This publication can be obtained on request by writing to Works Progress Administration, 1734 New York Ave., Washington, D. C.)

Labor Rulings

WAGE-HOUR administrator Andrews will be months in answering the hundreds of questions being presented by interested industry which seeks to observe the Fair Labor Standards law. Sincere effort is being made to prepare definitions and explanations that will assist in such observance.

It is realized by the Administrator that a great many companies will not be able to get sufficiently accurate statements of policy or legal interpretation to permit exact compliance in all particulars from the outset. It is hoped that a system of regional offices will greatly facilitate the work. But it will require considerable time to establish such offices, and still longer to inform them of official rulings and assist them in handling the many cases of their regions.

It is recognized that many mistakes will be made in the early stages of this work. Therefore, the Administrator has expressed his hope that no legal procedure will be undertaken to discipline those concerns which inadvertently may violate some feature of the law. He emphasizes his desire for a generous cooperation by industry in meeting the spirit of the law; and he assures business executives that those who sincerely try to comply with the provisions of the act will be excused for minor violations, especially when these departures from strict observance come about through incomplete or inaccurate information from the Government sources themselves.

The initial organization for carrying out the industry committee program will deal with the problems of the textile industry. A committee of 21 has been named, seven of whom represent employers, employees, and the general public. For each of the other major industry groups there will ultimately be such committee, but no maze of hundreds of committees for each of the fragments of American business. It is expected, therefore, that only a limited number of committees, possibly only one committee, will represent all metal-mining and related metallurgical work.

It is frequently assumed that these industry committees have the opportunity for modifying somewhat the limits on hours worked per week without penalty for overtime. That is not true. The committees will deal only with wage questions. And the mining industry, it is confidently expected, will have little trouble with the minimum wage question, as few, if any, of its workers are paid as little as 25c. per hour. The problems of overtime, where more than 44 hours per week are worked, will not be as simply solved unless a company decides that the required time and a half for overtime is the best answer.

Of course, where industry or company agreements with unions have acceptable contractual status, some features of the law are not rigidly applicable. However, the basic limits on the work-week will rarely, if ever, be modified except where seasonal exemption may be granted for certain classes of employment.

Washington has paid unusual attention to the report of the President's special committee, which, on its return from England, prepared and published a summary of the British labor relations situation. Naturally, the spokesmen of business have seized on the feature of this report which emphasizes the fact that organized labor enters in good faith into negotiations, and has sufficient disciplinary control over membership to make union contracts observed by labor as well as by management. New Dealers, on the other hand, stress the feature of the report which points out that British industry has fully accepted the philosophy of collective bargaining, and no longer struggles to limit the rights of organized labor in this respect.

Silver Coatings

STUDYING INDUSTRIAL uses of silver, the special Research Project investigators at the Bureau of Standards are giving attention to the ways in which coatings of this precious metal may be used for containers and process-industry equipment. The significance of these developments for three methods of application is shown in the following general comments which have been made by the research group:

"A large manufacturer of containers is showing much interest in the possibilities of silver-lined cans, and systematic work is in progress to determine how thin a lining can be used without encountering porosity problems. It has already been demonstrated that a thickness of 0.001 in. is satisfactory from every point of view except that of cost, and there is a certain market for even such a relatively high-priced container owing to the fact that silver is the perfect metal for maintaining flavor in stored liquids. As the thickness is reduced the market broadens, and at 0.0001 in. it would be very large.

"In the chemical tank field it has been amply shown that silver-clad sheet will stand all the punishment required to beat it into bowls or other dished shapes and still show good thermal conductivity. So-called brush plating, where a brush carrying a silver anode and moistened with a suitable electrolyte, apparatus for which is on the market, may have wide application in special cases. We hope to do our share in bringing about much wider adoption of chemical silverware. A minor possibility is the manufacture of silver-lined beakers, etc., to displace glassware with its greater fragility, and lesser heat conduction and resistance to certain chemical corrosives.

"A rather interesting possibility is the promotion of corrosion resistance by adding silver and then deliberately exposing the alloy to oxidation several times, with intermediate polishings. The idea is to get the surface layer enriched sufficiently in silver to exhibit the resistance to corrosion of silver. For example, copper, with silver added and so treated, appears to resist further oxidation better than pure copper."

News "Fines"

Confidential Mine Report—Miners are still struggling in the Federal courts to prevent the Bituminous Coal Commission from making public individual producers' cost data. These coal-mine executives are somewhat encouraged by recent appellate court injunctions, but the fact remains that coal has taken on the aspect of public interest so strongly as to have companies treated very much like public utility enterprises, whose books are in effect wide open for public inspection. It is logical to wonder how soon copper or aluminum or some other metal may be so regarded by officials!

Mexico—Progress at the State Department in solving Mexican problems has been substantially zero during the past month. If anything, Washington is more discouraged now than in early summer when the problems first became acute. However, hope never dies.

Price Policy—Working with ceramic tile manufacturers, the Federal Trade Commission is trying to demonstrate by the complaint procedure that any distinction between "wholesale" customers and those taking like quantities as "contractors" or "commission agents" is not a justifiable basis for different price schedules. Metal producers who market through parallel groups should anticipate that F.T.C. is going to persist in claiming that wholesalers and contractors are in effect in competition. Under this philosophy they must get equivalent quantities of goods at the same price, according to the Robinson-Patman law. Unless restrained by Federal court action in a broad way, F.T.C. will press this philosophy vigorously on all kinds of business.

Phosphate Land—The Congressional committee investigating T.V.A. is having a terrible time in making up its mind whether there were hidden and improper factors in the purchasing of phosphate mineral rock reserves for T.V.A. The propriety of purchasing is not questioned, but the profit of over half a million dollars made by a big fertilizer company continues to rouse suspicion and proddings into the deal by the legislators. Little or nothing has been heard in Washington during September about Western phosphate development. Senator Pope's defeat in the primaries, of course, accounts for this conspicuous inactivity.

Inter-Mineral Battle—One of the most bitter inter-mineral controversies that Washington has ever seen has developed in connection with the fight between coal and oil interests before the State Department committee dealing with the Venezuela treaty. This battle may, however, have indirect benefits for the rest of the non-fuel minerals. It is educating officials as to the fact that modern industry can hardly be monopolistic, since intercommodity competition restricts goods pricing. Copper vs. aluminum, tin vs. plastics for can coating, and like competition makes *intra*-industry competition seem a fairly polite and easy problem for modern management. It will probably be a good thing to have Government executives realize this, as their attention to anti-trust questions will then become a bit more realistic.

Recent Labor Angles in the Non-ferrous Metal-mining Industry

Sept. 4, 1938—The National Labor Relations Board today directed that an election be held within fifteen days among the production employees of **Eagle Picher Mining & Smelting Company** at its Henryetta, Okla., plant who were employed during the payroll period ended April 30, 1938, excluding clerical, monthly paid, laboratory, and supervisory employees, full-time watchmen, and those employees who have since quit or been discharged for cause, to determine whether they desire to be represented by International Union of Mine, Mill and Smelter Workers, Local 429 (CIO). The parties were in substantial disagreement only on the question of whether evidence introduced in behalf of the union was sufficient to justify the Board's certifying the union as exclusive representative without the holding of the election. Of the 380 employees who were in the appropriate unit as of April 30, 1938, 215 had signed cards by virtue of which the union was authorized to act as their representative. The company contended that 113 of these cards should not be considered in determining whether the union had a majority, on the ground that the employees who signed them had revoked their designation of the union as their bargaining representative by permitting themselves to become two or more months delinquent in the payment of their dues. In ruling that the proper procedure in the case would be to hold an election, the Board stated:

"It is not a requisite to representation of employees by a union that they be members of it; all that the Act requires is a designation of the union as their representative. Nevertheless, under all the circumstances of this case, we are of the opinion that doubt as to the employees' designation of the bargaining representative should be resolved by the holding of an election by a secret ballot, and we shall so direct."

Sept. 13, 1938—The National Labor Relations Board today directed that a second election be held among the production workers employed by **Utah Copper Company and Kennecott Copper Corporation** at their Arthur and Magna mills, Salt Lake County, Utah, excluding clerical employees and employees of the rank of foremen and above, to determine whether they desire to be represented by International Union of Mine, Mill and Smelter Workers, Local 372, affiliated with the Committee for Industrial Organization. Eligible to vote in the election will be those employees who are employed during the payroll period including Aug. 19, 1938, including those since laid off, but excluding those who have quit or been discharged for cause. In the first election held among the employees on Aug. 24, 1938, the union received 481 ballots, against 454 for Independent Association of Mill Workers, an unaffiliated labor organization, with 29 ballots cast for neither union, one blank ballot, and five void ballots. The Board found no merit in objections to the conduct of the first election which had been filed by the Association, and denied a petition by the Association requesting that its name be placed on the ballot with that of the union in the run-off election. In its decision providing for the run-off election, the Board said:

"It has been the practice of the Board, in cases where neither of two labor organizations participating in any election receives a majority of the votes cast, but their combined vote does constitute a majority, to provide for the conduct of a second election among the employees in the appropriate unit, to determine whether or not they desire to be represented by the organization which received the greater number of votes in the first election, provided that the organization indicates its willingness to participate in such an election. The Board sees no reason to depart from that practice in this case."

Sept. 13, 1938—Trial Examiner William Ringer of the National Labor Relation Board today recommended that an $18,000,000 lead company and its solely-owned mining company reinstate with back pay 130 striking employees, award remedial wages to 18 others, and cease and desist from encouraging membership in the Blue Card Union of Zinc Lead Mine, Mill and Smelter Workers, an American Federation of Labor affiliate, formed by the companies as part of their three years' campaign to discourage membership in International Union of Mine, Mill and Smelter Workers, formerly affiliated with the American Federation of Labor, but at the present time affiliated with the Committee for Industrial Organization. The companies are the **Eagle Picher Lead Company,** with principal offices in Cincinnati, Ohio, and the **Eagle Picher Mining & Smelting Company,** having plants in Cincinnati, as well as in Joplin, Mo.; Hillsboro, Argo, and Chicago, Ill., and Newark, N. J. The 130 employees are part of about 600 members of the International in the so-called Tri-State District (southeastern Kansas, northeastern Oklahoma, and southwestern Missouri) who conducted a strike beginning May 8, 1935, for the purpose of obtaining union recognition from the district's operators. Substantially all operations on mines, mills, and smelters in the district stopped under picketing of the then A. F. of L. union until May 28, 1935, when most of them resumed work through a back-to-work movement. Closing of the company's mines, mills, and smelters on the night of the strike, the trial examiner found, was "a reasonable measure in view of the announced intention for the strike" and not a lock-out, as claimed by the International, which brought the charges against the company. The trial examiner also recommended that the companies immediately post notices for a 30-day period in their plants at Picher, Okla.; Galena, Kan.; Joplin, Mo., and near Cardin, Okla., stating that it will comply with the examiner's recommendations, that it cease and desist encouraging membership in the Blue Card Union, and that the contract with the Blue Card union is null and void. If the company does not comply within ten days of the receipt of the examiner's intermediate report, he recommended that the National Labor Relations Board issue order against the company.

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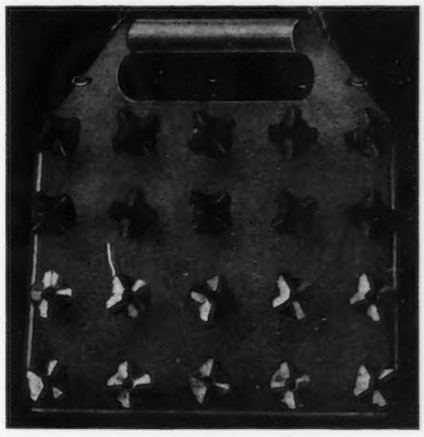

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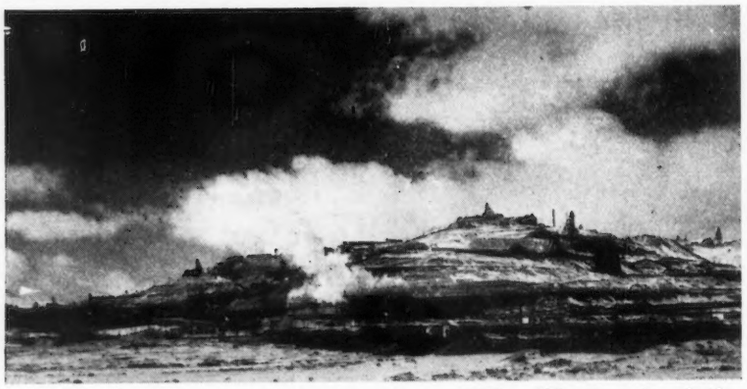


Activity in and around famous Butte Hill, (Montana), of the Anaconda Copper Mining Company, reflects the gradual improvement in the copper industry. The company recently reopened three of its mines

MONTANA

Anaconda Resumes Work at Three Mines

About 1,500 men return to work—Operations also resumed at copper refinery in Great Falls—Producers of siliceous fluxing ores encouraged by move

▶ On Sept. 6 production was resumed at the Belmont mine of the Anaconda Copper Mining Company at Butte. Employment will build up gradually to a total of about 800 men by December. The Steward mine also was reopened on Sept. 26, and the employment there will soon reach a total of about 600 men. These units will supplement production from the Anselmo mine, which has remained in operation during the summer, with an employment range of about 500 men. The Belmont mine was closed on May 27. All furnaces of the copper refineries at Great Falls had been closed during the summer, but these were started again during early September, and the zinc plant continued on the five out of eight unit basis. The indirect effect of these increases is difficult to measure closely, but it is certain that the increased employment will be generally noted in Butte, Anaconda, and Great Falls. In addition, there will be an increased demand for siliceous fluxing ores of the type produced by independent operators in many outlying districts.

▶ On Oct. 3 the Anaconda Copper Mining Company reopened the Mountain Consolidated mines, which also had been closed since May 27. About 4,300 men are now being employed by the company, compared to 1,600 earlier in the year.

▶ On Sept. 15, D. C. Jackling, president of the American Institute of Mining and Metallurgical Engineers, and A. B. Parsons, secretary, were guests of the Montana section. Following a dinner at the Butte Country Club, addresses were delivered by Messrs. Jackling, J. R. Hobbing, Anaconda executive vice-president; D. M. Kelly, Anaconda vice-president in charge of western operations; Dean Milnor Roberts of Washington University; Dr. F. A. Thomson, president of Montana School of Mines, and Mr. Parsons. Curtis L. Wilson, chairman of the local section, presided.

▶ Development is in progress at the Belmont mine, in the Marysville district, recently acquired by the Keystone Mining Company from the Cruse interests. Under the management of J. H. Thornton, deep-level exploration is being carried on while construction of a new 100-ton mill is being completed.

▶ Under the management of Percy Goodwin, the Gold Lode Mining Company, operating in the Vermillion district near Troy, has recently reconditioned its mill and plans in the near future to begin active operations.

COLORADO

New Drainage Tunnel Is Hope of Operators

Application made to PWA for funds to make new adit below Roosevelt drainage tunnel, in Cripple Creek district—Sunnyside Mining & Milling Company plans to eliminate long aerial tram

▶ A formal application for a PWA grant to supplement a bond issue for the driving of a new Cripple Creek drainage tunnel, estimated to cost $1,500,000, has been presented to the State Mineral Resources Board. The district operators met with the board when the application was considered. It calls for a grant of $675,000 by the Federal Government, to be supplemented by a fund of $825,000 to be raised by the Mineral Resources Board through the sale of bonds, the bonds to be liquidated by a royalty on all ore produced between the present Roosevelt drainage tunnel and the new tunnel. This tunnel, if approved, will run about a thousand feet below the present Roosevelt tunnel, and would drain an area of 30 square miles, or 20,000 acres, to a depth varying to 3,000 ft. below the surface. On the previous application, it was estimated that $5,000,000 worth of mineral might be reached. The tunnel would be over 5 miles long and would supply several thousand acre-feet of water yearly for irrigation use.

▶ In the Alma district there are several placer operations, three of which are washing a large yardage of gravel daily. The dredge of the Continental Dredging Company, from Breckenridge, Colo., was moved to Fairplay, Colo., and will be ready for operations about the middle of October. Also, the dredge of the Blue River Company at Breckenridge will be ready about the first of November. Charles J. Hallenbeck, road contractor, has developed a gold-placer machine now operating at the Lost Canyon Project. B. Hertzig is in charge.

▶ J. G. McKenzie, president of the Associated Metal Mines, Inc., Jamestown, Boulder County, states that his John Jay property is shipping some excellent ore and has a large tonnage of milling ore to be treated at the Acme mill.

▶ Walter A. Moore, organizer of the Colorado Gold & Silver Trust Company, has just completed negotiations in Boulder County for two mining properties and a mill. A bond and lease on the Ward group of claims and the Boston mill, a half a mile from the Ward mine, have been obtained.

▶ The Mines Development Association, under the management of T. K. Scott, has purchased the Sunshine mine, at Salina. This property is about half a mile from the milling plant, and according to engineers reports a large body of milling ore is available for development and exploitation.

▶ Rico Argentine Mining Company, Utah corporation, plans to erect a flotation mill on its properties at Rico, Colo.

▶ The Sunnyside Mining & Milling Company, at Eureka, has started grading a site for housing the equipment to be used in driving the new 16,000-ft. tunnel. This tunnel, when completed, will connect the mill and mine, and eliminate the present 33,000-ft. tramway. The site is immediately above the mill, and when completed will permit exploration in greater depth of several veins developed in the past. A satisfactory report has been made on the findings in the Sunnyside mine between the level of the famous Terry tunnel, for a distance of approximately 900 ft. below the former lowest opening on the vein system. A crushing plant between the portal of the tunnel and the mill will afford uninterrupted ore service and do away with the heavy maintenance and operations of the long aerial tramway.

▶ The new concentrating plant at the Cameron mine, in Grassy Gulch near Cripple Creek, will be completed soon, as will the wells being sunk for water for use in the mill. Mr. Turner, of the E. L. Sweeney Company, of Denver, is in charge of construction.

▶ Mining in the San Juan area advanced this summer. Stunner Mines, Inc., has made great progress, working the Eurydice group of claims near Summitville. Workings below the second level have been unwatered and construction of a

50-ton flotation mill has been completed. W. A. Perkins is manager. The Modern Gold Mines, Inc., at Dunton, recently made a number of test runs through the mill. Triplett and associates, operating the Hoffman mine, at Crestone, are mining copper ore containing some gold and silver from surface workings. The Blanco Mining Company, operating the Bandora mine, near Silverton, has started shipping ore to the Leadville smelter. C. S. Klingaman, with the Rainbow Electric Mining Company, is planning construction of a mill at Delta, Colo.

TRI-STATE

Higher Metal Prices Spur Activity

Many mines and mills idle for many months resume operations — Commerce Mining & Royalty Company increases working schedule from four to five days per week

▶ There was a good demand for zinc concentrates during September, but in view of the strengthening metal prices, operators were reluctant sellers. Shipments and production were on a level slightly over 7,000 tons of zinc concentrates per week. If the price gains are maintained, several more tailings re-treatment mills will probably soon resume operations. Because of the low tenor of the tailings being re-treated, this type of operation requires a higher concentrate price than has prevailed during most of this year to date.

▶ The Youngman & Youse Milling Company resumed operations at its tailings re-treatment mill, just north of Picher, in Kansas, early in September. The mill had been idle since the latter part of October, 1937. Approximately 25 men were reemployed, according to H. D. Youngman, company superintendent.

▶ The Jarrett mine and mill of the Federal Mining & Smelting Company, a mile west of Treece, Kan., resumed operations Sept. 5. The property, which had been idle since last December, employs approximately 50 men, according to L. G. Johnson, district superintendent.

▶ The Atlas Milling Company resumed operations at its tailings re-treatment mill, east of Picher, Okla., the first part of September, after being down since April of this year. Approximately 25 men were reemployed, according to R. O. Gibson, superintendent.

▶ The Cardin Mining & Milling Company resumed operations at its No. 2 tailings re-treatment mill in Picher, Okla., early in September after being down since last November. About 25 men were reemployed, according to S. L. Kenney, superintendent.

▶ Eagle-Picher Mining & Smelting Company has replaced the 12-in. Peerless turbine pump at the Garrett deep shaft with a 14-in. Pomona turbine pump. The new pump, which is powered by a 333-hp. electric motor, has twelve stages with especially designed working parts for the 435-ft. column. Pump capacity is 3,000 g.p.m. The shaft was unwatered on Sept. 15 and drifting operations were resumed on the 435-ft. level. Unusual precautions are being taken in advancing the drift, as the water head develops a pressure of 110 lb. at the drift face.

▶ Commerce Mining & Royalty Company has increased its working schedule from four to five days per week. The Bird Dog, Blue Goose, See Sah, Webber, and Wilbur mills and mines furnishing it with ore are affected by the new working schedule. St. Louis Smelting & Refining Company has also increased its working schedule at its No. 8 (Ballard) mill and tributary mines from four to five days per week. The new schedule went into effect the middle of September. Only a few of the smaller companies are now working fewer than five days per week.

▶ On Sept. 21 the St. Joseph Lead Company increased the rate of operations at its lead mines in Southeast Missouri, from six days every other week to four days each week. On Jan. 10 the company reduced operations from five days a week to six days every other week. About 2,500 men are employed at a minimum wage of $5.50 for an eight-hour day.

MICHIGAN

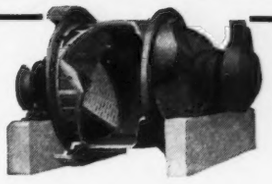
Operations at Isle Royale Continue at Good Rate

Production of 375 tons of copper metal per month is expected soon to be reached —Geological survey of mineral region completed

▶ Copper ore production at the Isle Royale mine is averaging 750 tons daily. This output will be increased as soon as some of the old levels are cleaned out. Much ground which had fallen while the mine was closed must be removed before good copper rock from these levels can be mined. The mine is well opened ahead. In the vicinity of Nos. 4 and 5 shafts, it is estimated there are 1,000,000 tons of copper rock ready for mining below the 25th level; 200,000 tons in a pillar on the 17th level, and 200,000 tons in shaft pillars, making a total of 1,400,000 tons. From this it is estimated that 32,000,000 lb. of copper can be produced. It is expected that a normal output of 750,000 lb. of copper per month will soon be reached.

▶ The geology division of the Michigan Department of Conservation has completed a geological survey of the southern part of Houghton County. The field of possible exploration has been mapped, which should result in a large saving of money in the search for new copper deposits. So far, the survey has resulted in the elimination of areas in which there is little likelihood of metal in commercial quantity. Several promising regions have been indicated, and these may receive attention in future explorations. The greater part of the district is unexplored, which leads to the belief that good copper-bearing lodes will yet be found.

WILLIAMSON MILLS



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IRON COUNTRY

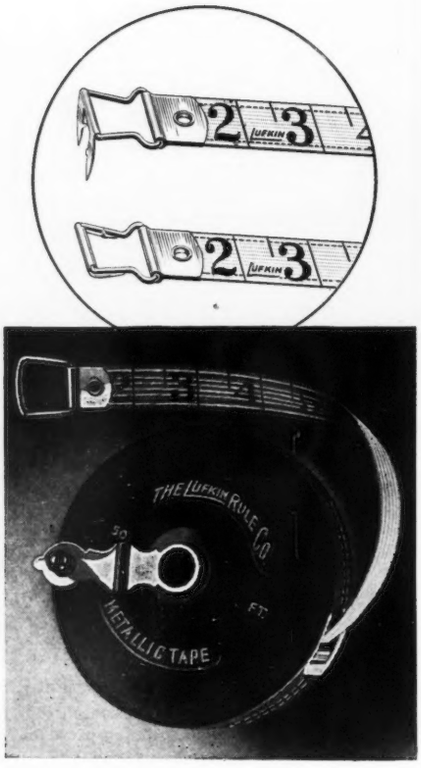
Slight Increase Noted in Iron Ore Shipments

Large stocks of ore available for consumption by steel manufacturers during winter months—Lease on Alexandria and Bruce mines canceled

▶ The consumption of Lake Superior iron ore at furnaces during August amounted to 2,076,819 tons. This compares with 1,674,721 tons for July. The ore on hand at Lake Erie as of Sept. 1 amounted to 37,050,338 tons and is the largest stock on hand at Lake Erie docks and furnace yards during the last several years. However, it is expected that with the present demand for steel tonnage, iron-ore stocks should reach normal by May 1 next year. Operations in the steel industry were close to 50 per cent of capacity at the end of September and several small increases in iron-ore shipments have been noticed.

▶ The Alexandria mine, at Chisholm, Minn., and operated by Republic Steel Corporation, is shipping stockpile ore and may clean up the stockpile. The lease on this property has been canceled and a stockpile clean-up will end all operations at this property.

▶ Bruce mine, at Chisholm, Minn., and operated by the Wisconsin Steel Company, is loading stockpile ore, and this stockpile will probably be completely removed this season and lease canceled.



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To fill old stopes at the Sullivan mine in British Columbia, two LeTourneau bulldozers are employed to push dirt into old shafts. Water from the suspended pipe soaks the material on its journey to the stopes

CANADA

Activity Broadens in Zeballos District

Large syndicate formed to prospect this promising area in British Columbia—Tidewater mine shipping copper concentrate to Japan—Lake Shore exploring Kirkland Basin property

▶ Concentration of ore at the Privateer mine, at Zeballos, one of the richest gold properties in North America, is scheduled to commence immediately, the 75-ton mill having been completed and the mine prepared for production. The actual grade of mill feed is still a matter for conjecture, depending on the amount of wall rock broken with the narrow vein and included in mill feed, but it is believed the average will be between $50 and $75 per ton. The ore indicated between the 600 and 1,000 levels is estimated to have a gross value in excess of $3,000,000, and it is sufficient in quantity to maintain production for two and a half years at the present rate. The vein was encountered recently at the 1,100 level, 164 ft. below the 1,000, and there it was found to have a width of 8 in. compared with 6 in. at the level above. Development costs have been paid out of the proceeds of crude ore shipped to the Tacoma smelter. Since May, 1937, these have amounted to $284,486. The mill and power plant have been financed by the sale of a quarter interest to Conwest Exploration Company, of Toronto. Gordon F. McDonnell is the engineer in charge and D. S. Tait, of Victoria, is secretary.

▶ Another Eastern company is negotiating for an interest in a Zeballos property. Anglo-Huronian, Ltd., of Toronto, has made a proposal to Spud Valley Gold Mines, Ltd., controlled by A. B. Trites, of Vancouver, concerning the Goldfield mine. It is understood reserves having a value of more than $1,000,000 have been developed at three levels during the past two years, and a 75-ton mill is now being installed. P. W. Racey, the company's engineer, reports that the mill will be ready for operation in November.

▶ Five large mining operators have formed a syndicate to prospect and develop properties in the Zeballos and other districts of British Columbia. The members are Bralorne Mines; Sheep Creek Gold; North American Mines, of Boston; Austin C. Taylor, of Vancouver; and Peter Bryce, of San Francisco. Several groups in the West Coast camp have already been optioned, comprising 178 claims. H. Grattan Lynch is directing operations.

▶ The eastern contact of the main Zeballos batholith is being explored with rather encouraging results at the Central Zeballos, Rey Oro, and Rimy mines. The downward continuation of the Central Zeballos orebody has been opened 325 ft. below the outcrop at the second level, which is 175 ft. deeper than the first. B. W. W. McDougall, the company's consultant, reports that ore has been developed at the new level for a length of 55 ft. to date, averaging 1 oz. gold per ton across a width of 4 ft.

▶ Copper concentrate is now being shipped to Japan from the Tidewater mine, where Japanese interests recently installed a 150-ton mill. The property is situated on the west coast of Vancouver Island and is owned by Sidney Inlet Mining Company. Allan J. Smith is the consultant and B. H. Melvin is in charge.

▶ Development at greater depth of the Bralorne, British Columbia's leading gold producer, is progressing satisfactorily, according to Richard Bosustow, managing director. At the 14th level, 600 ft. below the 10th, ore has been opened for lengths of several hundred feet to date in the "51" and "53", two of the four veins in the Empire zone, but some thousands of feet of work must be done at this level and at intermediate levels before the ore in the new block can be

estimated. During August, 15,006 tons was milled, and gold to the value of $301,350 produced.

▶ Mercury is now being produced on a small scale by Empire Mercury Mines from its property on Mud Creek, Bridge River district. Its prospects are of wide interest in view of the lack of mercury deposits elsewhere in the British Empire. C. P. Riel, president, reports that a 10-ton Gould reduction furnace has been installed to test the low-grade ore, which has been opened across a belt of greenstone and quartzite 1,400 ft. wide and 2,000 ft. in length.

▶ At the Cariboo-Hudson mine, 20 miles southeast of Wells, a crew of 105 men is engaged in completing the 100-ton mill and preparing the mine for the start of production about the first of November. Two 180-hp. diesel engines are being installed. James McDonald is superintendent.

▶ Sheep Creek Gold Mines has undertaken an extensive program of exploration, which includes the search for new veins at its present property, near Salmo, and the examination of promising properties in other mining districts. Bullion production in August was valued at $76,855, from 4,500 tons. Henry E. Doelle is manager.

▶ At the Reno mine, also near Salmo, the "4,900" tunnel has been started to open the Nugget and Motherlode veins at a further depth of 600 ft. The company has reduced its dividend by one-half to 1½¢ a quarter, in order that the present cash surplus of $365,000 may be preserved while the heavier development program is in progress. August output had a value of $55,050, according to the manager, W. S. Ellis.

▶ Good results are being obtained in development work at the Kootenay Belle, the third producer in the Salmo area. On the Dixie claim a vein has been exposed for a distance of 91 ft. to date, averaging 0.4 oz. gold across 36 in. The extension of veins from the adjoining Gold Belt mine onto the property is being explored. Bullion produced in August was valued at $54,000.

▶ The Wesko 100-ton mill was closed down on Aug. 20, as the supply of available ore was exhausted and the company had no funds for further development. Exploration by diamond drill is being continued and a decision will soon be reached with respect to future policy.

▶ Disappointing results have been obtained in recent work at the Bayonne mine, south of Nelson. There is ore ahead for three months' operation of the 50-ton cyanidation plant, and this may be augmented by development work now proceeding at the fourth level. The value of production in August was $30,040.

▶ The new underground mill at the Big Missouri mine, near Stewart, in the Portland Canal area, treated 18,893 tons of ore in July, from which bullion valued at $38,000 was recovered. The realization per ton averaged $2.01, and a good margin of profit is indicated by costs, which it is expected will be reduced to $1.50 per ton. The operation is controlled by Consolidated M. & S., and D. S. Campbell is superintendent. At the Salmon Gold operation a few miles distant it is reported that a shoot of ore 7 ft. in width and carrying good values has been opened for a length of 55 ft. to date on the 400 level. Work is being conducted by the Consolidated Company under an option agreement, and if a commercial deposit is disclosed it is believed it will be used to "sweeten" the mill feed at Big Missouri.

Manitoba

▶ Two more gold mines announced initial dividends in September, Moneta Porcupine and Laguna, in northern Manitoba. These bring the number of new dividend payers to seven since the first of the year, and increase to 60 the total number of Canadian mining companies now distributing profits to shareholders. Five years ago mining dividends in this country amounted to $27,922,642, compared with $103,949,472 distributed in 1937.

Ontario

▶ In his annual report on Lake Shore Mines, Dr. W. P. St. Charles, president, stated that net profits had been reduced from $4.15 a share for the fiscal year 1937 to $3.87 a share. A reduction in the average grade of ore put through the mill more than offsets the new record tonnage raised from the mine and caused a slight increase in operating costs per ounce of gold recovered. On a tonnage basis, costs were reduced. Bullion production averaged $16.19 a ton, although 58 per cent of the new ore developed by drifting showed an average gold content of $21.52 a ton. The No. 5 shaft was completed during the last fiscal year and work has now started on the new No. 6, which is intended to develop the mine below the 4,000-ft. level. Crosscuts and pilot raising have been completed down to a depth of 4,325 ft. Lake Shore has taken an option on the Kirkland Basin property to the north and is now exploring this new ground by means of a crosscut on the 3,075 level. Several years ago the north break was indicated by drilling 100 ft. from the north boundary.

▶ A summary of recent work at Bonetal Mines is given in an official report by James Y. Murdock. The property adjoins Hallnor and a 64 per cent control is held by Noranda Mines. High-grade ore over drift widths has been found similar to Hallnor conditions on both the 561 and 761 levels. This work is being done on the westward extension of the Hallnor vein. Drilling is being started on the lower level to search for parallel structures. While exploration is carried on from Hallnor underground workings, Bonetal will avoid the expense of shaft sinking. This ground is under option from Porcupine Creek Syndicate.

▶ The new mill of Macassa Mines, Kirkland Lake, went into production early in September. No change in rate of gold recovery is expected for another month, when daily tonnage will be increased gradually to a minimum average of 400. Macassa started milling five years ago and has maintained an ore grade similar to that of Lake Shore. Working costs

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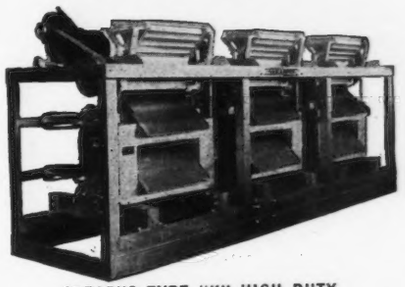

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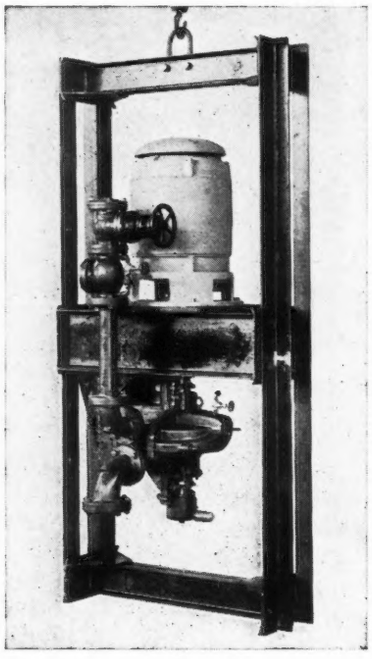

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▶CANADA

are slightly higher per ton, but under the cost figures for Wright-Hargreaves. A 600-ft. block of ground remains to be explored at the east end of the property, next to Kirkland Lake Gold, on the main break in the area below the 3,000 level. A block of three new levels has been established down to 3,725 ft., with an ore pocket 150 ft. below. In September work was started sinking a new deep operating shaft.

▶According to Dr. W. F. James, consulting geologist, favorable developments are resulting from underground exploration at the property of Chesterville Larder Lake Gold Mining Company, adjoining Kerr-Addison on the east. To a vertical depth of 470 ft. diamond-drill holes last year indicated more than a million tons of ore having a cut grade of $5.45. Shaft sinking was started last December and since that time drifting and underground drilling have explored about 65 per cent of the ore on the first level and 50 per cent on the second. Mill decision is being delayed until further information is secured to indicate whether selective mining would be more profitable than taking out all the ore as it comes.

Quebec

▶Production is to be increased to 250 tons a day at Sullivan Consolidated Gold Mines early in October, when the new 100-ton unit goes into operation. Three new levels are now being established at 950, 1,050, and 1,150 ft., opening up ore sections that have been explored by diamond drilling. In shaft sinking below the 900-ft. horizon a horsetail structure of narrow quartz stringers was intersected for a width of about 100 ft. Alteration to a straight shear is anticipated lower down, similar to conditions on the No. 4 ore zone. The average value per ton from 21 channel samples taken in the shaft was $8.53, suggesting that the stringer zone is going to make ore. Above and below this horsetail formation are two other structures that have given encouraging values in the course of previous exploration. The former mine superintendent, D. M. Parent, has been made mine manager. I. M. Marshall resigned as manager to take charge of the Naybob mine. H. D. McKecknie is geologist.

▶The Tavernier property of Lacoma Gold Mines has been unfavorably reported on by H. C. Wilmot, following his examination of recent exploration work on the 125-ft. level. It was found that granite would cut off the orebody at shallow depths, but the property will not be abandoned until two deep holes have been drilled. In the meantime, the company has taken over a group of claims adjoining the Abana mine of Normetal Mining Corporation.

▶Sigma Mines, subsidiary of Dome Mines in northwestern Quebec, broke all former records for monthly bullion shipments in August, with output valued at $151,699. Recovery averaged $7.67 a ton at an efficiency of 97.4 per cent. Daily average for the mill was 637 tons, the highest to be reported since operations were started a year ago last March. Net working costs were reduced to $3.75 a ton.

MEXICO

Labor Strife Threatens Operators in North

Strikers forestall shipments of coke to refineries in industrial centers—Custom mill being erected at Mazatlan, on Pacific Coast

▶Marking time and watchful waiting were the general trend in Mexican mining with the advent of fall. Efforts are still being made by the industry to gain relief from the 12 per cent federal tax on exports, which is hitting it hard. The Fresnillo Company, Fresnillo, Zacatecas, is confronted with a general strike threat because it cannot meet increased wages that are demanded. The management told the labor department that called conferences of representatives of all concerned in Mexico City, that the tax is causing it heavy losses. Labor trouble has popped up again, on a large scale. Several companies operating in the Santa Barbara districts are threatened with closing by strikes that some believe to be inevitable. However, development work in several regions continues, despite the economic depression that is becoming more acute. Expropriation of mines is thought to be out of the question—at least for the immediate present. Production of base metals, excepting copper, was at a higher level during the first quarter of this year than that of the same period of 1937. Exports, chiefly to the United States and Europe, are holding up well.

▶Refineries of the American Smelting & Refining Company are threatened with closure by a lack of coke as a result of the strike at the Rosita coal mines, in the State of Coahuila. Shipments of coke from stockpiles at Rosita are being held up by the strikers and it is reported that the steel plants in Monterry, Neuva Leon, are also threatened by shutdown due to lack of coke.

▶Central and western mines are to have additional refining facilities with the start of preliminary work for establishing a custom plant at Mazatlan, a Pacific port, by Central Metallurgical Company. This is to be the only gold-silver refining plant in western Mexico. The mill will have equipment for electrolytic, amalgamation, cyanide, flotation and ore concentration methods. Installations are being directed by Guillermo A. Burr, Mazatlan, who is to be general manager of the plant.

▶Iron deposits that were discovered recently by prospectors near Cerro del Piscila, Colima municipality, Colima, are to be worked by federal-supervised cooperative societies under the direction of Vincente Alvarez del Castillo, announces the Ministry of National Economy. As the deposits are near the main line of the National Railways of Mexico, the ministry views them as highly profitable because they can supply two of Mexico's largest cities—the national capital and Guadalajara, the Jalisco capital. The work is scheduled to commence this fall.

▶ Supreme Court decisions seem to have put the expropriated oil companies pretty much out of the picture, for, it is deemed, wage and other awards the tribunal has upheld will give the firms little if any indemnification.

▶ Exploitation of mining tracts in the Taxco district, Guerrero, is to be undertaken by an American-German-Mexican enterprise, Cia. Fundidora de Minerales Las Banderas, headquarters of which are in Mexico City. Members of the firm are Gaston J. Petitt, William Rudolph Seidel, Albert Wilhelm Ewald, and Lic. Benito Guerrera Leal. The company expects to start operations in October.

▶ Credito Minere y Mercantil, S. A., which finances a large sector of the mining industry and is directed by Mexican and foreign mining men and bankers, has opened an agency in London to look after its European interests.

YUGOSLAVIA

Trepca Mines Absorbs Three Companies

Lead and zinc producers have made a satisfactory fifteen-year agreement with Government—Construction of smelter and refinery gets under way

▶ The absorption by Trepca Mines, Ltd., of its three companion Yugoslavian companies, Zletovo Mines, Ltd., Kopaonik Mines, Ltd., and Novo Brdo Mines, Ltd., is now practically completed, all four companies having voted unanimously in favor of consolidation, and Selection Trust, Union Corporation, and Central Mining, the largest owners of the shares of the companies to be merged, being in full agreement. In consideration of the proposed establishment of lead and zinc smelters and refining facilities in Yugoslavia now under way, Trepca has secured important safeguards and special relief as respects currency control, rates of exchange, and taxation, the agreement with the Government extending for fifteen years.

▶ Trepca Mines, Ltd., is evidently employing the addition to its concentrator on its own ore, since Kopaonik Mines discontinued shipments because of low lead and zinc prices. In July Trepca milled 60,590 metric tons of ore (against 52,000 to 54,000 tons previously), recovering 6,622 metric tons of 78.83 per cent lead concentrates averaging 29.5 oz. of silver per ton, and 6,018 tons of 50.4 per cent zinc concentrates. During the quarter ended June 30 Trepca milled 161,604 tons of ore, for an operating profit of £81,129, or 10s. per ton, despite the exceedingly low ruling prices of lead and zinc. Net after allowing £20,241 for depreciation and Yugoslav taxation was £60,888, against £68,889 the preceding quarter when lead and zinc prices were appreciably higher. Trepca's hoisting and pumping installations are ready now for the development of the ore on the new deep level of the Stantrg mine, the 435-meter level. The mine is already opened up about six years ahead of the mill.

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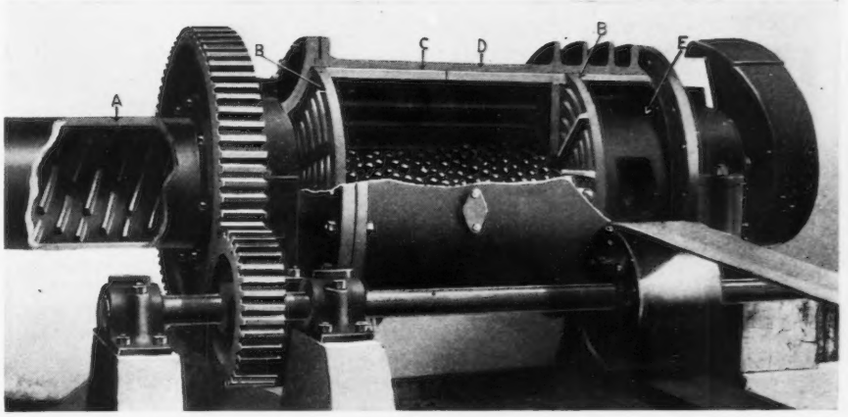

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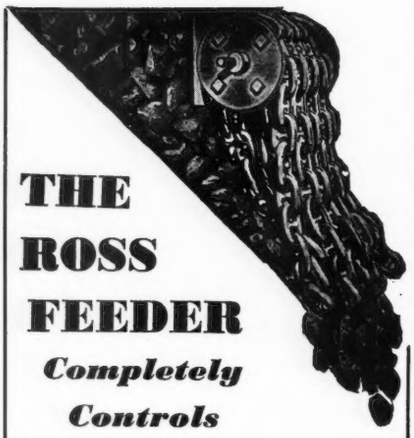

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AFRICA

Nchanga Will Be Dewatered To 1,000-ft. Level

Pumps being installed at 470-ft. horizon—Kimingini Gold Mining Company may discontinue operations at end of year

▶ Nchanga Consolidated Copper Mines is making rapid progress in the development of its big body of high-grade ore. Its two inclines had reached depths of 2,297 ft. and 2,259 ft. respectively at the end of August. These are sunk on a 15 deg. slope and freely connected with the workings so the miners can walk to the surface in the event of flooding. One will be used for pumping, the pump chamber being sealed off from the mine except for pipes controlled by valves. As the pump incline has reached a point near the workings which were flooded some years ago, vertical depth 470 ft., pumps are being installed to dewater the mine to that level. It will next be carried to the 1,000-ft. point and the whole area dewatered to that vertical depth. At the same time a vertical shaft is being sunk in the footwall for ore-hoisting purposes, and is already down 768 ft. An enlarged power house has been completed. It contains a 3,000-kv. unit to which a 6,000-unit set is being added. A second 6,000-kv. set has been authorized, and a third may be installed as a standby. A pilot plant is being erected.

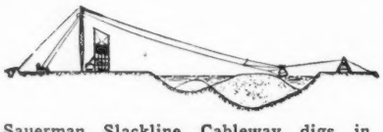
▶ Since the death of its principal, the firm of Sir Robert Williams & Company, which acted as mining engineers and managers of the Tanganyika Concession group of companies in Africa, has been dissolved. R. J. Morgan, who has been with the companies in Africa for many years, has been appointed chief mining engineer. In his latest report Mr. Morgan declares that the properties controlled by Kentan Gold Areas, Ltd., immediately south of Lake Victoria, now being equipped with a mill, show good promise of developing into a big gold undertaking, excellent values continuing to be found over good widths. Kimingini Gold Mining Company, Ltd., however, has discontinued development work, having failed to find extensions of the ores being worked. It has remaining some 11,540 tons of 8.1-dwt. ore, and when this has been exhausted, which will be by the end of this year, the company's operations in the Kakamego district will probably be discontinued and its assets realized.

▶ Witwatersrand gold production is establishing itself above 1,000,000 oz. per month. It was 1,021,501 oz. in August, and outside districts produced 25,887 oz., making the total Transvaal output 1,047,389 oz., a new high record. Production in July totaled 1,027,123 oz., valued at approximately $36,000,000.

▶ Diamond-drilling operations on the farm Gerhardminebron No. 4, about 55 miles by air southwest of Johannesburg, represent part of an exploratory program being carried on by New Central Witwatersrand Areas, Ltd., in an area now generally accepted as the western extension of the well-known Witwatersrand gold field. The final depth of the Gerhardminebron borehole was 10,718 ft.; by far the deepest borehole in South Africa to date. At a depth of 10,035 ft., a conglomeratic band or reef was intersected, which assayed 16.7 dwt. of gold over a corrected normal width of 12 in. The borehole, drilled by a Sullivan machine, was deflected and again intersected the same reef at 10,033. This reef has been identified as the Carbon Leader, a reef which has been located by exploratory drilling on the property of the Blyvooruitzicht Gold Mining Company, one of the younger developing mines in the West Rand. Whether this discovery represents a possible mining proposition or not is subject to debate. However, the remarkable extension of the Witwatersrand gold-bearing conglomerate lends interest in the development of the Rand.

▶ Despite the more or less common belief that gold deposits in Southern Rhodesia are apt to peter out at depth, some of the mining companies operating there are finding decidedly higher values in their deepest workings. Sherwood Starr Gold Mining Company, for instance, reports that its crosscut on the 22d level has cut heavily mineralized jaspilite, the first sample from which assayed 9 dwt. per ton over 48 in. and the face of this crosscut is still in ore. At a point 200 ft. east of point mentioned, a winze from the 21st level, also in jaspilite, a crosscut has disclosed 10.9 dwt. over 50 in. and the reef is not fully exposed. How important this discovery is, is indicated by the value of the 520,000 tons of ore in reserve being calculated as 4.4 dwt. per ton. The occurrence of values in the jaspilite is

Sauerman Slackline Cableway at Goldroad mill hauls tailing 1,000 ft. from old pile to bin on hill above floor of mill.



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WORTHINGTON

The HOLE SPOTTER

RD8-3

▶AFRICA

not a new discovery, nearly 90 per cent of the company's production coming from that formation.

▶Associated Manganese Mines of South Africa has resumed production and is shipping small lots of ore to Germany, in exchange, it is said, for machinery—a barter arrangement.

▶Ashanti Goldfields has cut higher-than-ever values in its deepest level, the 30th, the ore there averaging 58.3 dwt. over a width of 18 ft. It reports an even more remarkable disclosure on its other reef, the Cote d'Or, a crosscut on the 12th level there showing 123.2 dwt. over 21 ft. For the first eleven months of its current fiscal year this company's profits have totaled £919,641 on a capital of £1,000,000 in 4s. shares.

▶Roan Antelope Copper Mines has declared a final dividend of 6d. per share. This is equivalent to 1s. 6d. on its pre-bonus capital. The total of dividends for the year will be a shilling per share, calling for £998,217, this comparing with £998,133 paid from the preceding year's earnings. It has been estimated that the full year's earnings will be about £1,574,000 before taxation. The annual report will be issued in October.

AUSTRALIA

Mineral Survey Will Be Continued Two Years

Areas in Northern Queensland, and Northern and Central Australia will be investigated — Victoria Gold Dredging Company commences operations

▶Extension of the work of the Northern Australia Minerals Survey for another two years has been decided upon by a conference of the Federal and State ministers concerned. Recommendations as to areas to be surveyed, and estimates of cost, are to be submitted to the respective governments. The survey, which has been in progress for over three years, utilizes air force planes, with geological and geophysical ground parties, in the examination of promising areas in North Queensland, Northern and Central Australia, and the northwest part of Western Australia. The cost to date has been £150,000 Australian (about $600,000).

Western Australia

▶Gold production for the seven months to July 31 was 649,705 oz., an increase of 94,304 oz. over the corresponding period of 1937. The year's total should be about 1,200,000 oz.

▶Sinking on a new lode discovered recently 350 ft. west of the main shaft, Yellowdine Gold Developments, Ltd., Yellowdine, is meeting with promising results. At a depth of 44 ft. in the prospecting shaft, crosscutting revealed values of 27 dwt. over a width of 12 ft. Driving north and south from the crosscut, values to date have varied from 17 to 23 dwt. per ton.

▶Tindals Gold Mines, Ltd., Coolgardie, has placed orders for a treatment plant of 5,000 tons' monthly capacity. Operation is expected in about twelve months' time. Proved and probable ore reserves total 322,000 tons of an average grade of 5 dwt.

▶South Kalgurli Consolidated Ltd., Kalgoorlie, announces ore reserves at March 31 last of 186,000 tons proved, and 101,000 tons of probable ore, the grade averaging 5.5 dwt. per ton. The total is up 9,000 tons on the figure of a year earlier, but grade has dropped about 0.2 dwt. per ton. Another Kalgoorlie producer to improve its ore reserve is Gold Mines of Kalgoorlie, Ltd., which at March 31 had reserves of 338,000 tons of an average grade of 6.6 dwt. per ton, or three and a half years' mill supply. The increase in reserves during the year was 95,300 tons.

▶Lake View & Star, Ltd., Kalgoorlie, continues on steady lines, and is at present treating 55,000 short tons per month, with a like tonnage of old tailing, for a working profit of slightly over £50,000 Australian monthly.

▶Yellowdine Gold Areas, N. L., a company which was originally formed to develop leases on the Yellowdine field, but had no success there, is at present prospecting, with considerable promise, a new find at Mount Jackson, 42 miles north of Bullfinch. One prospecting shaft is down to 26 ft. with values of 2 oz. per ton over a width of 40 in., and in another to a depth of 31 ft., values range from 1 to 5 oz. per ton. Ground and lode conditions are considerably disturbed, however.

Victoria

▶The most important development of recent weeks has been the commencement of operations by Victoria Gold Dredging Company, N. L., at Newstead, near Castlemaine. In opening-out operations from July 11 to July 30, a total of 55,000 cu.yd. of overburden and gravel was put through for a yield of 440 fine oz., or 3.84 grains per cubic yard. Subsequent returns have been even better, nearly 600 oz. of gold weekly having been recovered with an average grade of over 10 grains per cubic yard. The exceptionally good yields are ascribed to the presence of coarse gold on the bedrock, which evidently did not enter the bore-samples when the ground was drilled, as the bore values of this particular part of the area averaged 4.5 grains only. The dredge got into operation with a minimum of mechanical trouble, the only alteration found necessary being an adjustment to the stacker conveyor handling overburden.

▶Directors of Adelong Gold Estates, N. L., which is operating a small steam-driven dredge near Bright, are giving consideration to the provision of improved equipment for the property. At the outset of operations, five years ago, it was estimated that 5,750,000 cu.yd. were available, a quantity well within the estimated life of the dredge, but since then the area has been greatly extended until now probably 18,000,000 cu.yd. could be dredged. The company is noteworthy for its profitable operation on low-grade ground—for the six months to April 30, 386,750 cu.yd. were dredged for a yield of 1,061 oz. gold (1.25 grains per cubic yard) and a profit of £2,729 Australian was realized, total costs being 3.18d. (approximately 5.3¢) per cubic yard.

▶Promise of the development of another large alluvial area in the Northeast is contained in the announcement of the exercise by Tronoh Finance, Ltd., of London, of the option held by it over the Harrietville area of Beechworth Alluvials, Ltd. This area, situated 15 miles from Bright, is reputed to contain 60,000,000 cu.yd. of wash, and to be suitable for deep bucket dredging.

New South Wales

▶During the half-year to June, New Occidental Gold Mines, N. L., Cobar, reports that 41,887 tons of New Occidental ore were cyanided for a yield of 14,226 oz. gold (7.96 dwt. per ton) and 16,876 tons from the New Cobar mine treated by flotation for concentrates containing 223 tons of copper and 4,442 oz. of gold. At this mine, No. 4 level has been opened up and is in regular production, and No. 5 is in progress of development. Two diamond-drill holes recently intersected good-grade ore below this level, and three winzes have also been sunk to an average depth of 90 ft. At the New Occidental Mine, No. 10 level is being opened up with widths and assays closely comparable to those of No. 9. It is intended to use shrinkage stoping for No. 10 and lower levels, and this is expected to result in a considerable saving of cost as compared with that of cut-and-fill, employed in the higher levels.

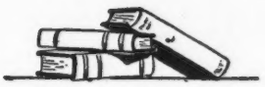
▶Evidence of metallurgical improvements at Broken Hill is contained in the annual report of Zinc Corporation, Ltd., which shows that in the last four years recoveries of lead and silver in lead concentrate have been improved from 94.5 per cent to 96.5 per cent, and from 90.8 per cent to 93.4 per cent respectively, and that of zinc in zinc concentrate from 80.2 per cent to 85.9 per cent. It is estimated that on the tonnage treated in 1937, the revenue increase due to these advances has been worth more than £50,000. The improvements have not come from any major changes in method but have been due to constant minor refinements in operating practice.

Tasmania

▶Montana Silver-Lead, N. L., of Zeehan, has just concluded a successful mill-scale test of its ore at the mill of North Mount Farrell, Ltd., Tullah. Flotation methods proved suitable for the concentration of the ore, yielding good-grade concentrates, with high recoveries of both lead and silver. Current expenses are being met by the shipment of high-grade galena from the mine, but consideration is to be given to the erection of a milling plant.

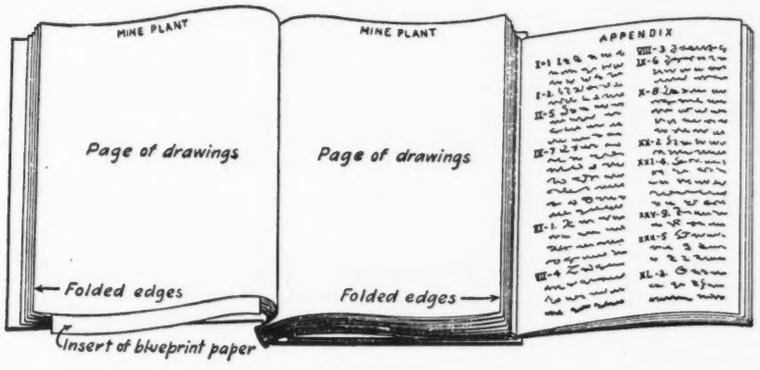
▶Magnet Silver-Lead Mines, N. L., of Magnet, near Waratah, has completed mill construction, and plans to enter on production immediately. The plant, which employs gravity methods, with flotation of the gravity tailings, has a capacity of 750 tons weekly.

NEW BOOKS



MINE PLANT. *By Benjamin Franklin Tillson. Rocky Mountain Fund Series. American Institute of Mining and Metallurgical Engineers, 29 West 39th St. Price $7.50 ($5.00 to members of the Institute). Pp. 371. Size 9 in. wide by 11½ in.*

IN THIS VOLUME of mine-plant drawings, with their accompanying references and explanatory notes, we have a most unique contribution to the technical literature of the mining industry (and here let no one quibble over the term "literature"). In fact, there is no other volume like it. It is peculiarly the product of Mr. Tillson's versatile genius, coupled with his great capacity for hard work. The scheme devised whereby a sheet of blueprint paper may be slipped between each unslit pair of pages to permit a copy of either page to be made, not only is novel but was made possibly only through much effort to find a paper that was at once durable and sufficiently translucent to permit blueprinting through it. The sketch, herewith produced from the inside of the volume's front cover, is sufficiently explanatory of this device and of the mode of using the 50-page appendix of notes. The book is divided into three parts: Surface plant (12 chapters), Shaft plant (11 chapters), and Underground plant (17 chapters). The drawings are listed and described briefly in the 12-page table of contents. In all there are over 1,120 figures, consolidated under 841 main captions.



The drawings themselves are, of course, the main thing. Selection was influenced by (to quote from the introduction) the "suitability of the design, its suggestiveness for future applications, and what it could add to the completion of a review of the various ways of meeting the demands of mining operations." The age of a design was considered immaterial "compared to its modernity for similar conditions . . . and its value to mines with modest capital resources." Again, "the activity or inactivity of a mine is not a proper index of the value of a design which is or was used in it." Here the proof of the pudding must be found in the eating. The value of the book, unquestionably great for many, must necessarily depend on the user. The competent engineer will find ideas and save himself much labor, at the same time working surely. To those less skillful in design but nevertheless having it to do, the book should be a life saver.

As for the author, we name him as our candidate to receive the Institute's next award for the most outstanding contribution to mining literature.

THE MINERAL INDUSTRY, 1937. *Edited by G. A. Roush. McGraw-Hill Book Company, Inc. New York and London. Pp. 766. Price $12.*

AS a preface to the current volume, No. 45, of this standard reference work, the editor offers a review of the mineral industry for the quarter century 1913-1937. The period corresponds with that of his own editorship for 25 years, which in itself is a service worthy of recognition. Undoubtedly the successive volumes have gained in authority, reliability, and accuracy under the continuing attention of Mr. Roush, more than they would under a succession of short-term editors.

But the review has additional values in that the period selected is probably one of the most momentous quarter centuries in the world's history. It includes the World War and the world-wide economic and industrial depression that followed twelve years later. Finally, it closes with 1937, during which the world mineral industry practically recovered the 1929 level of production.

For the purpose of his review Mr. Roush selects a group of individual branches of the industry that represent a cross-section of the whole. Selection is determined not only on the basis of great bulk or value, but equally on the economic and industrial importance of the minerals even though relative quantities and values be low. Hence his list includes coal and petroleum; pig iron and the ores of manganese, chromium, and tungsten; copper, lead, zinc, aluminum, and tin; phosphate rock and potash; gold and silver; and diamonds.

These sixteen products play so large a part of the world's economy that they are used for the calculation of a world index of mineral production that is set forth in tabular and graphic form. Thus the relation between each commodity and the whole group is readily seen at a glance.

Like preceding volumes, the current issue covers adequately the metals and minerals from "abrasives" to "zinc." The chapters are contributed by more than 30 authorities in the United States and abroad, and each commodity is treated with respect to source, production, price, trade, technology, and use. Bibliographies are added in some instances. Useful addenda are tables giving the value of foreign coins in United States money, names and addresses of State geologists, mine inspectors, and commissioners, trade and professional organizations in the United States, current tariffs on mineral and metal products, and weight-conversion factors.

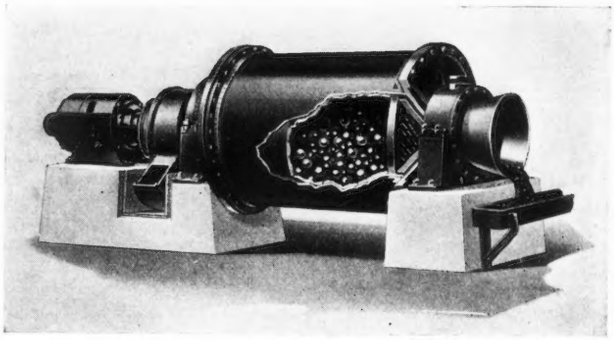
GRADE OF ORE. *Mineral Technology and Output per Man Studies; O. E. Kiessling, Economist in Charge. Works Progress Administration National Research Project and Department of the Interior Bureau of Mines. Request for copies should be addressed to Publications Section, Division of Information, Works Progress Administration, Washington, D. C.*

THIS 114-page bulletin points out that the mining industry in this country has long since skimmed the "cream" of most of the rich mineral deposits and is now faced with the problem of working grades of ore which a generation ago would have been considered almost worthless. The ingenuity and inventiveness demanded by this decline in ore grades has brought about great improvements in mining techniques. In spite of decreasing metal content per ton of ore, technical progress has produced a rising output per worker for all major metals.

This study is prefaced by a brief description of early "bonanza" mining when a pick and shovel were the principal items of equipment, and discusses the technical advances which have made possible the profitable working of low-grade ores. Separate chapters are devoted to gold and silver ores, copper, lead, and zinc.

In a final chapter on output per man it is pointed out that approximately one-half the nation's present copper supply comes from mines which were known but considered worthless in 1900; that silver and gold deposits with one-tenth the yield required for profitable production 50 years ago are being successfully worked today, and that in spite of a 27 per cent decline in ore yields in lead mines in the last quarter of a century, such deposits are still being worked at a profit. "Metal mining," the report states, "has had to adjust itself to a lower grade of ore, and the success of this process has been one of the important victories of mineral technology."

Why a GEARLESS Ball Mill?



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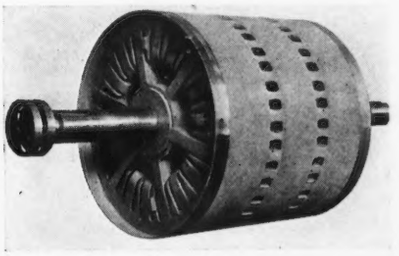
EQUIPMENT NEWS

Inkless-Type Recording Instrument

A MECHANISM using a typewriter ribbon as the marking medium has been announced by the General Electric Company, Schenectady, N. Y., as an addition to the line of recording instruments employing the conventional inking system. The development eliminates such hazards as spillage, evaporation, freezing, and clogging of pens. Additional advantages include the maximum reliability over a wide temperature range, high accuracy, since pen-to-paper friction is reduced, and low service maintenance. Successful operation is obtained at temperatures as low as —10 F.

Magnetic Pulley

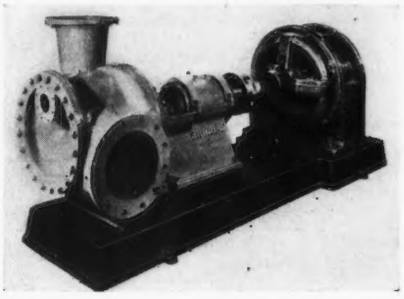
STEARNS Magnetic Manufacturing Company, Milwaukee, Wis., announces new feature in its high-duty magnetic pulley. The system of specially designed air ducts has been improved. Coil windings are more efficient, due to greater cooling area furnished by the forced air circulation and caused by the compressive action of the belt which forces the cooled air into the ribbed interior of the pulley on the upper side and expels the heated air by the suction of the belt on the lower side. In this way, a constant stream of cool air is circulated through the pulley, completely around each steel-ribbed bobbin on which the coil is wound.



New Foam-Liquid Slime Pump

THE BINGHAM Pump Company, 705 East Main St., Portland, Ore., announces the development of a new foam-liquid slime pump that permits pumping of flotation concentrates without the necessity of breaking down the foam by addition of water. As designed, the new unit, when handling foaming liquids, separates out and exhausts the foam or gas through an exhaust vent, and delivers the material through the pump discharge at an uninterrupted even rate of flow. By preventing the accumulation of foam or gas in the volute or impeller eye, air-binding or reduction of pump capacity is said to be eliminated. Its use also makes installation of gravity launders unnecessary. The pump has no valves or metal-to-metal contacts; therefore, wear is said to be reduced to a minimum. The rotating element is the only moving part.

Labyrinth type deflector discs protect



the cylinder-housed bearings against oil leakage and entrance of foreign materials or moisture. Leakage through the stuffing box is prevented by multiple rings of packing. All parts of the pump are easily accessible, and the impeller and pump casing may be inspected quickly by simply removing the suction piece. The most approved corrosion- and abrasion-resistant metals are used in its construction.

Ink for Use on Glass

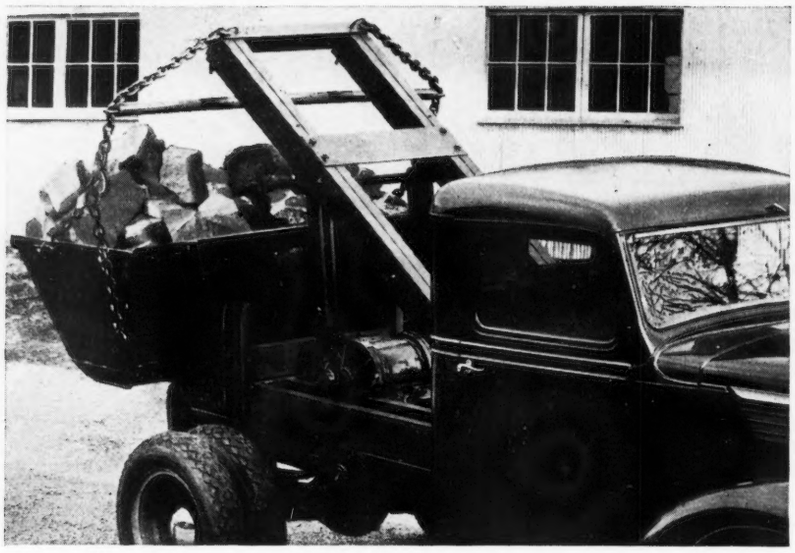
A NEW INK is now available in white and black for writing on glass or enameled ware and is known as "S. R. L." Brand LN Glass Ink, sold by the Stewart Research Laboratory, 315-22d St., Washington, D. C. It can be applied with any steel pen, drawing pen, or fine brush. The permanency is increased by gently warming the writing. The ink is non-corrosive and is non-inflammable. It can be used to mark permanently microscopic slides for reference purposes, and for making mine models, and it also forms a resistant coating for reagent bottles containing acids or alkalies.

New Easy-Reading Steel Tape

A NEW WYTEFACE STEEL TAPE, one-third lower in price than previous models and designed for general use, is announced by Keuffel & Esser Company, Hoboken, N. J. The new tape has black graduations on a crack-proof white surface, easy to read, even in poor light. This improved visibility is said to be a great convenience and a valuable safeguard against costly errors. Elimination of the usual etching process leaves the steel at full strength, giving the line a marked resistance to kinks or curls.

The white surface is firmly bonded to the steel, protecting it from rust and corrosion, greatly increasing the useful life of the line. It is available in 25-, 50-, 75-, and 100-ft. lengths.

B. F. Goodrich Company, Akron, Ohio, announces the development of a new rubber trolley-wire guard designed especially for mine service. It is made of cloth-inserted sheet rubber 3/32 in. thick by 9 in. wide, which is folded double and cured in a permanent "U" shape. It is said to provide complete protection for the workmen because, as indicated above, the material flexes or bends in either direction to give dependable safety against high voltage. The feeder pole is said to slip through the guard without the slightest obstruction and installation is said to be simple and economical. The material is supplied in 50-ft. lengths.



BROOK Equipment Manufacturing Company, Knoxville, Tenn., announces a "Load Lugger," for use in transporting stone, ore, and other aggregate loaded by hand.

BULLETINS

Indicating Pyrometers. The Foxboro Co., Foxboro, Mass. Bulletin 193-3 describes the manufacturer's indicating pyrometers of the mono-pivot type, portable pyrometers, and resistance therometer indicators. Pp. 8.

Centrifugal Pumps. Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Form 7069 describes and illustrates the company's end-suction centrifugal pump. Style CRV, for various industrial purposes. Pp. 15. **Wet Stopehammer.** Form 2409 describes and illustrates all parts of the new SA-90 stopehammer. Pp. 6. **Light-weight Portable Compressors.** Form 3264 is an attractive brochure illustrating the company's three new light-weight models of air-cooled portable compressors, the smallest delivering 55 cu. ft. of air per minute, the next size 85 cu. ft. of air per minute, and the largest 105 cu. ft. of air per minute. Specifications and general data are included. Pp. 23. **Centrifugal Pumps.** Form 7067 gives complete specifications of the Cameron two-stage centrifugal pump. Pp. 13. **Turbine-Driven Pump.** Form 2390 describes the new Class TRV unit assembly turbine-driven pump. Pp. 2.

Concentrating and Washing Tables. The Deister Concentrator Co., Fort Wayne, Ind. Bulletin 23B describes and illustrates the company's Diagonal Deck, Deister-Overstrom concentrating and washing tables and accessory equipment. Pp. 20.

Thickeners and Clarifiers. Hardinge Company, York, Pa. Bulletin 31B describes the manufacturer's thickeners and clarifiers for thickening, clarifying, and settling in the metallurgical and other industrial fields. Pp. 4.

Wood Preserving. Carbolineum Wood Preserving Co., 528 West Highland Ave., Milwaukee, Wis. Folder 102 describes simple method of preserving mine timbers and other lumber for industrial use. Pp. 4.

Vibrating Screens. Deister Machine Co., 1933 East Wayne St., Fort Wayne, Ind. Bulletin 26 describes and illustrates features of the Deister Plat-O heavy-duty vibrating screen. Pp. 11.

Variable-Speed Transmission. Ideal Commutator Dresser Co., Sycamore, Ill. Form SST-638 describes the manufacturer's compact "Select-O-Speed" transmission for various industrial uses. Pp. 4.

Power Shovels. Bay City Shovels, Inc., Bay City, Mich. Pocket-size booklet illustrates and describes features of the company's digging shovels. Pp. 14.

Hand Tachometer. O. Zernickow Co., 15 Park Row, New York, N. Y. Leaflet describes the O-Z improved hand tachometer P. 1.

Telephone. Telephone Systems Co., 120 Greenwich St., New York, N. Y. Folder describes a telephone performance for factory, village, office, or home that requires no cost for power. Pp. 3.

Mining Machinery. Straub Manufacturing Co., Inc., 507 Chestnut St., Oakland, Calif. Catalog 302 is a comprehensive 8½x11-in. edition of the manufacturer's products, illustrating and describing Ribcone ball mills and other types of mills, spiral classifiers, plain jigs, and smelting furnaces. Blueprints of mill layouts and sectionalized machinery and flotation equipment are included. A Spanish edition of this catalog is also available. Pp. 40.

Grinding, Classifying, and Amalgamating Unit. Sundfelt Equipment Co., 3315 First Ave., South, Seattle, Wash. Bulletin 24 describes units for capacity of 10 and 20 tons. Pp. 2.

Flotation, Non-metallic Minerals. Denver Equipment Co., 1400 Seventeenth St., Denver, Colo. Bulletin 38M4 is reprinted from Bureau of Mines Report of Investigation 3397, by Oliver C. Ralston, chief engineer, Non-metals Division, Bureau of Mines. Entitled "Flotation and Agglomerate Concentration of Non-metallic Minerals," the bulletin describes results of modern practice employing flotation on non-metallics. Pp. 32.

INDUSTRIAL NOTES

J. F. Mitchell-Roberts, export manager in the New York office of Oliver United Filters, Inc., arrived in India the latter part of September for an extended stay. He can be reached at the Taj Mahal Hotel, Bombay.

A. D. Marriott, manager of The Dorr Company's metallurgical division, has returned to Denver, completing a ten-month tour of metallurgical installations in the Philippines, Japan, and Australia. **T. B. Ford,** manager of the company's Tokyo office, arrived in Vancouver Sept. 6 for a vacation of several months in the United States. **Arthur Terry,** managing director of Dorr-Oliver N. V., The Hague, has returned to Europe after a month's visit with his associates in the United States.

In the largest expansion and modernization program undertaken in the non-ferrous metals industry since 1929, Bridgeport Brass Company announced the completion in September of a new $4,500,000 rolling mill at Bridgeport, Conn., for the production of brass, copper, and copper-base alloys for industrial and commercial use. Ralph E. Day is president and general manager. The plant is estimated to have a production capacity of over 6,000,000 lb. of metal per month.

The Jury of Award of The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, after judging thousands of papers submitted in the $200,000 award program, found that savings to industry by arc welding claimed by authors of papers aggregates $1,600,000,000. Altogether, 382 awards were made by the Foundation. The amounts ranged from $101.75 for honorable mention to $13,941.33, the Grand Award. Recipients included engineers, designers, architects, production managers, superintendents, draftsmen, shop foremen, mechanics, inspectors, welding operators, welding supervisors, owners of businesses, college professors, high-school instructors, students, and others. Subjects of studies in the 44 divisions of the program, represented practically every product and structure of industry. In the processing machinery division, covering mining equipment, George T. Dexter, engineer, Puget Sound Sheet Metal Works, Seattle, Wash., received 1st award of $712.28 for his paper, "Redesign of Mounting Base for Diesel Driven Mining Pump," a discussion of many advantages which the author attributes to arc-welded construction. Second award of $508 in the division went to co-authors Eugene A. Balsley and Charles A. Schneider, engineers, Link-Belt Company, Chicago. Their paper, "Arc-Welded Design of Wash Box," features redesign for welding and attributes a cost saving of $2,143.76 per unit to arc-welded construction, also lower erection costs, less corrosion, greater rigidity, and lower transportation cost. An award of $305.26 went to G. O. Marrs, consulting engineer, Universal Equipment Company, Denver, Colo., for his paper "Arc-Welded Roaster for Oxidizing Roast of Pyritic Gold-Bearing Ore." Awards of $101.75 went to the following authors of papers on mining subjects: Harold B. Coulter, chief mechanical engineer, The Dorr Company, New York, paper: "An Arc-Welded Ore Classifier"; Asher H. Patten, chief engineer, Denver Equipment Company, Denver, Colo., paper: "Evolution of the Flotation Machine From Wood to Steel"; William J. Edbrooke, designing engineer, Bucyrus Erie Corporation, Milwaukee, Wis., paper: "Ribbed Construction Adapted to Placer Dredge Digging Ladder"; Charles S. Roach, Fairmont Machinery Company, Fairmont, W. Va., paper: "Field Welding of Coal Tipples." The Grand Award of the Foundation's program went to Mr. and Mrs. A. E. Gibson, president and stockholder, respectively, The Wellman Engineering Company, Cleveland, Ohio. The authors jointly received $13,941.33. Their paper is an outstanding treatise on all the elements required to assure the business and technical success of all users of welding throughout industry. The Foundation's Award Program, which began eighteen months ago, was judged by 31 engineering authorities from leading universities and colleges throughout the country.